BIOLOGICAL OPINION

IMPACTS OF THE LAXARE EAST & BLACK CASTLE CONTOUR COAL MINING PROJECTS ON THE INDIANA BAT

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CONSULTATION HISTORY

Table 1. Summary of section 7 consultation history for the proposed actions.

Date	Event/Action
7/23/03	Service concurred with mist-net survey plan for three proposed Black Castle mines.
7/24/03	Service notified that a post-lactating Indiana bat was captured in mist-net survey at upper Sandlick Creek on 7/23/03.
7/30/03	Service was notified that a second post-lactating Indiana bat was captured in mist-net survey at the mouth of Orchard Branch on 7/29/03.
7/31/03	Tom Chapman and Shane Jones of the WVFO met with Apogee Consultants and Mark King, Allen Ashley, and Michael Snelling (the applicants).
8/5/03	Service verbally informed Russell Woody of Gaddy Engineering that logging within two miles of the capture sites might result in take of Indiana bats.
8/6/03	Service met with applicant, the WVDEP, and the Corps of Engineers to discuss consultation options.
8/7/03	Service received facsimile Pre-Construction Notice (PCN) from Corps for Black Castle mine.
8/8/03	Service letter faxed to John and Ellen Bullock of Gaddy Engineering advising them how landowners they represent may avoid take of Indiana bat.
8/11/03	Service's 8/8/03 letter faxed to Russell Woody, John Bullock of Gaddy Engineering, and Jim Hamer of Jim C. Hamer Co.; Service law enforcement officer called Mr. Woody and Mr. Bullock inquiring about status of logging.
8/12/03	Service was informed by Jim Dearing of Jim C. Hamer Co. that logging ceased in Orchard Branch on 8/4/03; Service verbally advised by Mark Taylor of Corps that they would prepare a biological assessment (BA).
8/13/03	Service informed by Mr. Dearing that logging ceased in Morgan's Branch that day; Mr. Bullock informed Service that no logging activity occurring on client's property.
8/15/03	Service received 8/13/03 Corps PCN on West of Stollings mining project.
8/18/03	Service received 8/14/03 letter from Mr. Dearing stating that logging ceased, and requesting that we inform them when to continue logging.
8/21/03	Service received 8/19/03 letter from attorney Larry W. George, stating that he represented the majority of the landowners of the Peytona tract/Black Castle mine site and to keep him informed as consultation proceeds.
8/21/03	Service received Corps PCN for the Laxare East mine.
8/26/03	Service received mist-net survey reports (2) from Joel Beverly for the Black Castle Contour, Checkmate Amendment, Short Ridge, Laxare East, Lexerd, and West of Stollings mining projects.
9/11/03	Service received the 9/9/03 Corps PCN for Lexerd mining project.

Date	Event/Action
9/17/03	Corps received draft BA from Apogee Environmental Consultants.
9/19/03	Service advised by Allen Ashley of Black Castle Mining Co. that the draft BA was sent to the Corps.
10/16/03	Service letter to the Corps stating that due to negative mist-net surveys and no portals (mine openings) the Lexerd and the West of Stollings mining projects are not expected to adversely affect endangered species.
11/20/03	Service received letter of transmittal and BA from Huntington District Corps on four proposed mining projects – Black Castle Contour, West of Stollings, Laxare East, and Lexerd surface mines; Service biologist was queried by Joel Beverly of Apogee about conducting logging before March 31, 2004.
12/8/03	Service biologist conducted site visit and met with applicant; applicant stated they wanted to cut 435 acres before 3/31/03, and requested Biological Opinion by 2/1/04; Service biologist informed Mark White of Black Castle Mining that an incidental take statement is needed before this can occur.
12/19/03	Service letter to the Corps stating all information necessary to initiate formal consultation has not been received, requesting additional information, and requesting clarification on whether the Checkmate and Short Ridge mining projects would be included in the consultation.
12/22/03	Service faxed 12/19/03 letter to the Corps to applicant's consultant.
12/23/03	Service biologist was e-mailed revised draft BA by the applicant's consultant to determine whether it contained requested additional information.
12/30/03	Service biologist provided comments to applicant's consultant on revised draft BA, advised them that the BA was a Corps document, and that our request for additional information had been to the Corps.
1/5/04	Nationwide Permit (NWP) authorization for West of Stollings.
1/5/04	Service received revised draft BA from applicant's consultant (with some of the requested information, but not addressing all of the Service's 12/30/03 comments).
1/6/04	Service biologist received e-mail from applicant's consultant addressing Service's 12/30/03 e-mail comments on revised draft BA.
1/7/04	Service biologist received two e-mails from applicant's consultant responding to Service's 12/30/03 comments on revised draft BA; Service biologist called Corps biologist and left voicemail asking whether the Corps intended to include the Short Ridge and Checkmate Amendment mining projects in the BA.
1/8/04	Service biologist sent e-mail to applicant's consultant questioning whether the Corps would include the Checkmate Amendment and the Short Ridge mining projects in the consultation.
1/12/04	Service received revised BA from Apogee Environmental Consultants (still includes Checkmate and Short Ridge projects).
1/14/04	Service biologist called Corps biologist and left voicemail asking whether the Corps intended to include the Short Ridge and Checkmate Amendment mining projects in the BA.
1/20/04	Service learned from West Virginia Division of Environmental Protection

Date	Event/Action
	(WVDEP) that an application had been received in October 2003 for an Article III permit for an amendment to the Black Castle Contour Mine.
1/20/04	Service biologist received call from Bill Raney of WV Coal Association, expressing concern about Black Castle Coal Co.'s need to cut timber in winter.
1/22/04	Service biologist informed WVDEP mining biologist that the Corps would consult on only two of the four mining projects associated with the Indiana bat .
1/28/04	Service met with Corps and WVDEP to discuss how to address Elk Run mining projects not covered under consultation with the Corps.
2/5/04	Service received letter of transmittal and third revised BA from Corps (Checkmate and Short Ridge projects were removed).
3/1/04	Service met with the applicant on their changes to the proposed project (timber clearing in spring of 2004).
3/4/04	Service sent letter to WVDEP informing them that formal consultation was going to be initiated with the Corps and that they should coordinate with the Service on any permits the WVDEP had in the project area.
3/5/04	Service received letter of transmittal and revised BA from Corps (with new timber clearing acreages for 2004).
3/9/04	Service sent letter to Corps confirming initiation of consultation, and requesting portal (mine opening) and other information.
3/10/04	Service received revised BA and portal (mine opening) survey information from applicant. Conference call between the Service and the Corps to discuss formal consultation process.
3/12/04	Service received letter from the WVDEP acknowledging that they will review their permits and coordinate with the Service on Indiana bat issues.
3/25/04	Service received letter from Corps regarding revisions to the BA, providing additional information, and clarifying how they intended to incorporate any terms and conditions of the biological opinion into a potential Corps permit.
5/14/04	Service sent letter to applicant requesting that they conduct additional surveys under coordination with the Service.
5/20/04	Corps sent letter to the applicant informing them that their projects do not qualify for authorization under nationwide permit, and that additional information would be required before an individual permit application could be processed.
6/17/04	Conference call between the Service and the Corps regarding the need for additional information regarding minimization measures and the implications of the revised permitting process and recent court decisions to the ongoing consultation. (The applicant was invited to attend this call but declined.)
7/01/04	Service received Corps' 6/27/04 public notices on the Laxare East and Black Castle Contour projects.
7/12/04	Service receives call from applicant informing us that additional Indiana bats had been captured on site. Applicant had not coordinated survey plans with the Service or informed the Service that work was being conducted.
7/26/04	Service sent comment letters to the Corps regarding the 6/27/04 public notices.
8/18/04	Conference call between the Service and the Corps to discuss the status of the company's response to the Corps' additional information request and coordinate efforts on the permitting and formal consultation processes.

Date	Event/Action
10/27/04 - 10/28/04	Service met with the Corps and applicant to discuss consultation status and tour the action area.
11/8/04	Service sent information request regarding verification of numbers, future mining plans, additional water quality data, and draft RPMS to the applicant.
11/24/04	Applicant responds to Service regarding verification of numbers and future mining.
11/29/04	Applicant responds to Service regarding water quality data, and ability to minimize fills.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Corps is proposing to issue two Clean Water Act section 404/surface mine permits for the Laxare East [public notice (PN) 200300886] and the Black Castle Contour surface mines (PN 200200258) in Boone County, West Virginia. Boundaries for the two permits and the action area (discussed below) are shown in Figure 1.

The Clean Water Act section 404 permits address the filling of Waters of the United States and the associated impacts of the proposed surface mines. The proposed Black Castle Contour Mine was authorized with an Article III mining permit (S-5023-00) by the West Virginia Department of Environmental Protection (WVDEP) on January 14, 2003. The proposed Laxare East Surface Mine was authorized with an Article III mining permit (S-5012-00) on June 17, 2003. No previous Endangered Species Act section 7 consultations have occurred on these projects. Consistent with the nationwide permit process, the U.S. Army Corps of Engineers, Huntington District (Corps) issued a pre-construction notice (PCN) for the Black Castle Contour on August 7, 2003, and for the Laxare East surface mine on August 19, 2003. On May 20, 2004 the Corps determined that these two projects did not qualify for authorization under nationwide permit and took discretionary authority to process these two projects under individual permit review. As a result, public notices for these projects were issued on June 27, 2004. Both mining projects are proposed by Elk Run Coal Company, a subsidiary of Massey Energy Company. Each of these projects is discussed in greater detail below.

Action Area

The action area includes the Laxare and Black Castle Contour mining areas (Figure 1). Both mining projects require a permit from the Corps for wetland and stream encroachments related to mining activities (*e.g.*, valley fills, sedimentation pond construction). Were it not for the wetland and stream encroachments associated with the Corps proposed permit(s), the surrounding upland areas would not be accessible for mining. Therefore, the action area includes both proposed mining areas in their entirety, not just the wetland and stream encroachment areas.

Various mining activities (*e.g.*, blasting, haul road construction and use, valley fills, forest clearing, earth disturbance) may result in off-site effects to the environment, as well as to the

Indiana bat (*Myotis sodalis*). Therefore, the action area includes not only the footprint of the Laxare and Black Castle Contour mining areas, but also a 0.7-mile area beyond this footprint. Because the Service was not able to locate buffer information regarding mining near tree roosting bats, this distance is based on the structural protection and auditory buffer distances recommended by the WVDEP and the Pennsylvania Department of Environmental Protection for mining operations. Any off-site sedimentation resulting from tree-clearing and earth disturbance would also be anticipated to occur within this area.

The action area includes the headwaters of Sandlick Creek, Long Branch, Morgan Branch, Burnside Branch, Laurel Creek, and Mudlick Fork will be impacted by valley fills originating from the Laxare and Black Castle Contour project areas and are included in the action area. In addition, as a result of the proposed mining and fill, these streams will be subject to water quality effects for an unknown distance downstream; therefore, the action area also includes these streams for an undefined distance below the valley fills.

The Service estimates that there are approximately 5850 acres and 25 miles of streams, within the action area. The additional length of streams subjected to downstream water quality effects is unquantifiable and is therefore not included in the above calculation of the action area.

Project Description

The overall purpose of the projects is to mine coal; however, the purposes of the Clean Water Act section 404 permits are to: 1) regulate the disposal of excess overburden generated by mountaintop removal, contour, and highwall/auger mining of the Buffalo coal seam and all underlying seams; 2) provide sediment control in order to reduce sediment discharges; and 3) regulate outlet discharges during precipitation events.

Mining would be accomplished by first clearing the proposed mine area of all trees and constructing sediment ponds within existing stream channels. Large excavators and dozers would be used to remove the tops of the mountains areas from the surface down through the 5-Block and Clarion seams, where the coal would then be extracted. Waste material from the removal of the topsoil and rock overlying the coal seams (overburden) would be disposed of in the valleys over the stream channels to create the proposed valley fills. All forest land and streams within the project footprint will either be removed or filled during the course of the mining. Project impacts are summarized in Table 2, and discussed in greater detail below.

Table 2. Overview of project impacts.

	Laxare	**Black Castle Contour**	**Total**
Forest removal (total acres)	1534	665	2199
Proposed forest removal outside hibernation period[1]	210	80	290
Stream loss (miles)	6.95	5.0	11.95
# of Valley Fills	8	11	19
# of sediment ponds	12	8	20

1: Only proposed for 2004, see" Conservation Measures" section.

Laxare East Surface Mine
The proposed project is located in Orchard Branch, Long Branch and unnamed tributaries of Sandlick Creek and Morgan Branch just north of Sandlick Creek and just east of the headwaters of Left Fork Rock Creek, near Peytona, West Virginia. Mining operations on this project would occur between elevations of 1,000 and 1,900 feet and on slopes generally greater than 20 percent. The applicant's proposed operation would affect 1,534 surface acres, including 1,126 acres of subsurface mineral removal to recover approximately 23.5 million tons of coal reserves. This operation would generate approximately 266 million cubic yards of overburden, of which roughly 188 million cubic yards would be placed on the mined areas as backfill, and the remaining 78.5 million cubic yards of excess overburden would be placed in the proposed valley fills. Best management practices will be used for sediment control during mining operations.

This acreage includes habitat which will be disturbed by the construction of stream crossings, haul roads, sediment ponds, and other facilities associated with both mining projects.

Eight valley fills and 12 valley fill ponds are proposed for construction under this permit. Valley fills C and D are existing valley fills in unnamed tributaries of Sandlick Creek that would be expanded by the proposed Laxare East permit. All of the proposed valley fills would drain watersheds of less than 250 acres. It is estimated that a total of 6.95 miles or 36,745 linear feet of stream will be directly affected by fill during the life of the Laxare permit. The applicant describes most streams that will be affected as ephemeral and intermittent. The majority of the stream corridors have forested riparian habitat.

Mining would begin on 210 acres at the western end of the project, and would include clearing trees and constructing sediment ponds. After this, mining would begin moving slowly eastward. It is estimated that this project will be finished 12 years from when mining begins. All acreage (1,534 acres) within the footprint of the project would be de-forested during project construction.

Black Castle Contour Mine
The proposed project is located in unnamed tributaries of Mudlick Fork, Laurel Creek and Sandlick Creek, and in main Sandlick Creek, approximately 3.2 miles east of Williams Mountain, West Virginia. Mining operations on this permit will occur between the elevations of 900 and 1,400 feet and on slopes generally greater that 20 percent.

The applicant's proposed operation would affect 665 surface acres and would generate approximately 43 million cubic yards of material, of which approximately 2.5 million cubic yards would be placed in the proposed valley fills. The approximately 40.5 million cubic yards remaining would be placed on the contour to backfill and eliminate a highwall. Best management practices will be used for sediment control during mining operations. This acreage includes habitat that will be disturbed by the construction of stream crossings, haul roads, sediment ponds, and other facilities associated with both mining projects.

The Black Castle Contour project will have eight, new valley fill sediment ponds (seven existing sediment ponds will also be used) and 11 valley fills. Nine of the proposed valley fills would be expansions of existing valley fills. Valley fills 2, 3, 4, 5, 6, 7, 8, and 10 are existing fills that will be utilized by the proposed Black Castle Contour. All of these valley fills are in the Laurel

Creek watershed, except for valley fills 10 and 11, which are in the Sandlick Creek watershed. All of the proposed valley fills would drain watersheds of less than 250 acres. It is estimated that a total of 5.0 miles or 26,437 linear feet of stream will be directly affected by fill during the life of this permit. The applicant describes most streams that will be affected as ephemeral and intermittent. The majority of the stream corridors currently are forested riparian habitat.

Mining would begin on 80 acres located on the western slope in Georges Branch (a tributary to Laurel Creek). This would include clearing trees and constructing sediment ponds. In subsequent years, mining would proceed around Georges Branch and No Name Hollow (hollow immediately west of Georges Branch). The life of the Black Castle Contour project is expected to extend over seven years. All acreage within the footprint of the project would be de-forested during project construction.

Reclamation

The applicant proposes to reclaim both mine areas (Black Castle Contour and Laxare) “as closely as possible” to pre-mining conditions. However, no maps showing post-mining contours or topography have been provided to the Service. Post-mining land use is proposed to be forestland. Although no timetable for reclamation has been provided to the Service, the Corps’ BA indicates that for the Laxare and Black Castle Contour permits, only 300 and 200 acres, respectively, can be disturbed at any one time. After completion of mining, disturbed areas would be temporarily seeded, covered with six inches of topsoil or topsoil substitute material, limed, graded, and mulched. Areas would then be seeded with a mixture of perennial grasses, and “appropriate areas” would be re-planted with a mixture of white pine (*Pinus strobus*) and red oak (*Quercus rubra*) at a rate of 450 seedlings per acre. The BA does not specify where the appropriate areas are; how many acres are considered appropriate; or include any performance measures to ensure reclamation goals are achieved.

Stream Mitigation

Conceptual plans include creating intermittent streams within permit boundaries on the down slope portion of the mining area by transforming sediment cells at the lowermost seam of mining into a meandering stream with riffles and pools. Ephemeral stream sections are proposed to be created using the center drain of valley fills that flow with water during rain events. Temporary impacts to ponded streams are proposed to be mitigated by removing ponds when mining is completed and restoring the streams to pre-disturbance conditions. However, no detailed stream mitigation plans to address the effects of ponding existing streams and covering streams with fill have been provided to the Service for either project.

Conservation Measures

The applicant has included the following conservation measures as part of the proposed project:

- The BA proposed to conduct tree clearing activities for 210 acres on the western end of the Laxare permit and 80 acres within the Black Castle Contour between April 16 and May 31, 2004. Tree clearing on all other areas of the proposed project would be conducted between November 15 and March 31. During these time periods bats are expected to be in hibernation, and therefore would not be present on site. However, as of May 31, 2004 the applicant had not received all the permits required to proceed with the project, including a valid incidental take permit. Therefore, to date, no tree clearing outside the hibernation period should have occurred. As a result, the remainder of this BO will assume that all tree clearing activities on the proposed projects will be conducted between November 15 and March 31 of future years, unless additional information is received indicating otherwise.

- Implement a post-mining re-vegetation plan that will prevent erosion, provide future travel corridors and foraging areas for Indiana bats, and includes trees known to be used by Indiana bats. No success criteria or performance measures, beyond those described in the *Reclamation* section above, have been provided;

- Provide the following alternative roosts and watering areas to replace those lost by mining;

    - Alternative roosts (rocket-style bat boxes) will be placed on ridgetops and south-facing slopes. Bat boxes will be placed in groups of five in proximity to watering areas and will range from the forest edge to completely in the open (equal spacing between each box).

    - Watering areas will be constructed in upland areas (near bat boxes). Watering areas will be approximately 8 feet (2.4 m) by 12 feet (3.7 m) and will be 3 feet (1 m) deep, and located on ridgetops and south-facing slopes near wooded areas.

    - A watering area and group of five bat boxes will be constructed for every 250 acres lost during the proposed mining in the action area. The applicant proposes monitoring and maintaining these features for 5 years, and providing a monitoring report.

- Leave summer habitat on the lower slopes for mountaintop removal projects, and the lower and upper slopes for contour mine projects; and

- Restore streams to the extent possible.

STATUS OF THE SPECIES

Listing History
The Indiana bat was listed as endangered by the Service pursuant to the Endangered Species Preservation Act on March 11, 1967 (32 Federal Register 4001). Listing was warranted based primarily on large-scale habitat loss and degradation, especially at winter hibernation sites, and significant population declines that continue today. These and other threats are discussed below.

Thirteen winter hibernacula (11 caves and two mines; Table 3) in six States were designated as Critical Habitat for the Indiana bat in 1976 (41 Federal Register 187). The only designated critical habitat in West Virginia is Hellhole, a cave located in Pendleton County, approximately 135 air miles from the action area. Hibernacula priorities I through III are based upon population sizes at the various sites. Priority I: hibernation sites with a recorded population >30,000 bats in a given survey since 1960 (although two of these sites currently have extremely low numbers of bats); Priority II: recorded population >500 but <30,000 bats in a given survey since 1960; and Priority III: <500 bats (Service 1983).

Table 3. Designated critical habitat locations.

STATE	CAVE (sites)	MINES (sites)
West Virginia	Pendleton County (1)	
Tennessee	Blount County (1)	
Kentucky	Carter (1) and Edmonson (1) Counties	
Illinois		La Salle County (1)
Indiana	Crawford (1) and Greene (1) Counties	
Missouri	Crawford (1), Franklin (2), Shannon (1), and Washington (1)Counties	Iron County (1)

Recovery Plan

In 1975, the Indiana bat Recovery Team presented a Recovery Plan to the Service (Service 1975), however, this plan was never finalized. In 1983, the Service completed a Recovery Plan for the Indiana bat (Service 1983), and in 1999 the Service (1999b) has completed an agency draft of a revised recovery plan for the Indiana bat. The 1999 draft recovery plan (1) incorporates new information on the Indiana bats life history and ecology, especially information on its summer ecology that has been gathered since 1983; (2) highlights the continued and accelerated decline of the species; (3) recommends continued site protection and monitoring efforts at hibernacula; and (4) places a priority on research to determine the factor or factors causing the species' population decline.

Threats

Indiana bats have been described as "once one of the most common mammals in the Eastern United States" (Tuttle et al 2004). Between 1960 and 2004, a 56 percent population decline has been documented (Clawson 2002; see below). A variety of factors have contributed to range-wide Indiana bat population decline including flooding and ceiling collapse in winter hibernacula (Service 1983). This often resulted in the adverse changes to the hibernaculum microclimate by affecting temperature and humidity. Other documented cases of Indiana bat declines include: (1) blocking cave entrances or installation of gates that do not allow for bat ingress and egress, or disrupt cave air flow; and (2) human disturbance during hibernation. These changes resulted in either die-off during hibernation due to freezing, or starvation as the higher temperatures increases the bats metabolism. This can result in the burn off of limited fat reserves that are required to survive hibernation and emergence in the spring. In this situation, the Indiana bat does not have the ability to awake from hibernation, leave the cave, forage for additional sustenance, and return to the cave to complete its hibernation cycle. It simply starves.

Because many known threats are associated with hibernation, protection of hibernacula has always been a management priority, however, disturbance to hibernacula continues to be a threat to the Indiana bat. For example, the largest hibernacula in Indiana (50,941 Indiana bats in 2003) is not gated, and based on electronic monitors in the cave, unauthorized visits to this cave occur. Also, at the only large hibernacula in Ohio (9,436 Indiana bats in 2004 – a decrease from the previous two counts), there are still tours, as well as other commercial activities, taking place in the cave during the hibernation period

Despite the protection of approximately half of the known major hibernacula (Currie 2002), range-wide population declines continue. In the last fifteen years, appropriately constructed bat gates have been correctly installed in caves, allowing for protection of hibernating bats and restoration of the microclimate. Although most of these efforts were completed by 1990 and resulted in some recolonization of traditional hibernacula, there have not been corresponding overall population increases (Clawson 2002). Possible reasons for this are that the species' reproductive capacity will take much longer than 10-20 years to show population gains, and other environmental factors continue to negatively affect the species, or both.

It must be noted that hibernating populations in the north appear to be stable and/or increasing while hibernating populations in the south are decreasing. However, because of the migratory behavior of this species and other reasons described below, it is not prudent to differentiate between different geographical ranges with regard to wintering populations. The range-wide decline has led leading scientists to conclude that additional information on Indiana bat summer habitat is needed (3D/E 1995).

Land use practices have been identified as a suspected cause in the decline of the Indiana bat, particularly because habitat in the Indiana bats' maternity range has been changed dramatically from pre-settlement conditions in the following ways: the vast majority of old-growth forests have been harvested and remaining forests are fragmented to varying degrees; fires have been suppressed; prairies have been replaced with agricultural systems; native plants have been replaced with exotics; and diverse plant communities have been simplified. These changes can have profound effects through factors such as loss of suitable roosting habitat caused by the removal of large trees, and by a reduction of the diversity and abundance of insects on which the Indiana bats prey (Service 1983; Kurta and Murray 2002; Kurta et al. 2002; McCracken 1988; Racey and Entwistle 2003).

In addition to an increased focus on Indiana bat summer habitat, attention has also being directed to pesticide contamination (Clark et al. 1987; Clawson 1987; Garner and Gardner 1992; Callahan et al. 1997; 3D/E 1995; O'Shea and Clark 2002; Kurta and Murray 2002). Insecticides have been known or suspected as the cause of a number of bat dieoffs in North America, including endangered gray bats in Missouri (Mohr 1972; Reidinger 1972; Clark and Prouty 1976; Clark et al. 1978). The insect diet and longevity of bats also exposes them to persistent organochlorine chemicals that may bioaccumulate in body tissue and cause sub-lethal effects such as impaired reproduction (O'Shea and Clark 2002).

Summary
In general terms, the overall population decline of the Indiana bat is the result of mortality exceeding recruitment (i.e., deaths are outpacing recruitment). The specific reasons for this dynamic remain unknown. However, it is likely that higher mortality rates occur during migration and hibernation due to the energy demands of these events than during routine foraging and roosting activities in summer habitat.

The annual cycle (for females) of hibernation, spring migration, parturition, lactation, fall migration, mating, and hibernation can be broken at any point, resulting in the loss of that female from the population, and her remaining reproductive potential in the population. Because of the reproductive limitations of the species, healthy females are capable of producing only one pup per year. At some point(s) in this annual cycle, the species is experiencing higher mortality rates or lower recruitment than it did historically, causing the species' population to continue a steady decline. Between approximately 1990 and 2000, a 19 percent decline occurred. The vulnerable point(s) in this cycle may very well differ by geographic area, and even within the same area. Ransome (1990) further identifies the limiting factors that control overall bat population as the number of maternity colonies and the proximity and quality of foraging areas surrounding each maternity site. He also concludes that a reduction in the number of maternity colonies contributing to a hibernaculum is a prime factor that should be considered when evaluating the causes of population declines in bats. The number of bats found in individual caves is regulated by the number and sizes of maternity colonies that contribute to those caves (Ransome 1990). MacGregor clarifies that many other factors affect cave populations (Service 2004c). Unless a change in these environments occurs to allow recruitment to exceed mortality, the species will continue to decline.

Distribution
The Indiana bat is a migratory species whose range encompasses much of the eastern half of the United States (Figure 2). As of January 2001, the Indiana bat had been recorded in 311 counties, scattered across 27 states (Gardner and Cook 2002). Preliminary genetic studies indicate that, the species appears genetically uniform throughout its range with the exception of New York and Vermont as a distinct or unique population (Bob Currie, personal communication**,** Service). The winter/summer populations in Vermont and New York appear to be isolated in that the majority of individuals followed from hibernacula appear to be migrating short distances to establish maternity colonies in close proximity to the hibernacula. Elsewhere throughout the range, rather than one large meta-population, the Indiana bat functions as hundreds or thousands of smaller sub-populations. Since mating takes place at the hibernaculum during fall swarming, genetic exchange is a result of the contribution of many smaller populations, or maternity colonies, congregating at one hibernaculum (Service 199b).

The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range.

Based on unpublished internal guidance, the Midwest is considered the “core maternity range” (Service 1999b) for the Indiana bat because of the large number of hibernating bats found there and because it harbors over 80 percent of the known maternity colonies. The “core maternity range” is generally recognized as the portion of the Indiana bats’ range in close proximity to where most of the population hibernates (i.e. Priority I and Priority II hibernacula in Indiana, Kentucky, and Missouri), while the non-core range includes those areas located further from the majority of the Priority I and Priority II hibernacula. This terminology was developed when the main threat to the species was thought to be disturbance to hibernacula and less was known about the migratory nature of the Indiana bat. Regardless of the terminology, the range wide population has continued to experience a downward trend even though an incredible amount of effort has been expended to protect many hibernacula.

Indiana Bat Population Status

Due to the colonial nature of Indiana bats, conducting censuses of hibernating bats is the most reliable method of tracking population/distribution trends range-wide, and provides a good representation of the overall population status and distribution. As such, winter distribution of the Indiana bat is well documented.

For several reasons, interpretation of the census data must be made with caution. First, winter census data is broken down by State due to the nature of the data collection. As described below, each State does not represent a discrete population center. Nevertheless, the range-wide population status of the Indiana bat has been organized by State. Second, as will be further discussed, available information specific to the “reproductive unit” (i.e., maternity colony) of the Indiana bat is limited. While winter distribution of the Indiana bat is well documented, little is known as to the size, location and number of maternity colonies for the Indiana bat. As described below, it is estimated that the location of approximately 90 percent of the maternity colonies are unknown.

Additionally, the relationship between wintering populations and summering populations is not clearly understood. For example, while it is known that individuals of a particular maternity colony come from one to many different hibernacula, the source (hibernacula) of most, if any, individuals of any colony is not known. As discussed in the “Spring Emergence/Migration” section, Indiana bats have been documented to travel up to 300 miles from their hibernaculum to their maternity areas (Gardner and Cook 2002). As such, the origin of the bats (hibernacula) that comprise the maternity activity in the action area are unknown. As depicted in Figure 6, there are numerous hibernacula within the known maximum migration range from the Boone County site. Bats within the action area may very well be hibernating in any of six states in addition to West Virginia (three different states if these bats behave similar to limited documented occurrences in which individuals migrated north from their hibernaculum to maternity areas).

Range-wide Hibernacula Censuses

Within 100 miles of the action area, there are several Priority III hibernacula within West Virginia, Kentucky and Virginia and Priority I and II hibernacula in Virginia and Kentucky (see “Listing History” for definition of Priority I, II and III hibernaculum). Therefore, individuals from the action area may hibernate in a variety of different priority hibernacula.

Based on the 2003 winter census, Indiana has four Priority I hibernacula and Kentucky and Missouri each contain three Priority I hibernacula. Priority II hibernacula are known from the aforementioned states, in addition to Arkansas, Illinois, New York, Ohio, Tennessee, Virginia, and West Virginia. Priority III hibernacula have been reported in 17 states, including all of the aforementioned states. In the 2001 hibernacula census, the total known Indiana bat population was an estimated 380,000, down from approximately 880,000 bats in 1960 (Table 4), and approximately half of these hibernated in eight Priority I hibernacula (excluding Dixon Cave, Kentucky, which may not have reached the Priority I threshold) (Clawson 2002). Censuses began in the late 1950s, and since then many winter counts have decreased, especially in Kentucky and Missouri. Overall, the population has declined 56 percent since the 1960s (Clawson 2002). Caves in Kentucky suffered dramatic losses because of changes in microclimate due to poor cave gate design in two of the three most important hibernacula (Humphrey 1978), and Indiana bat numbers continue to decline. Despite recovery efforts, Indiana bats in Missouri caves have declined with a loss of more than 80 percent of the population (Clawson 2002). From the 1960s/70s to the most recent population census (2003/2004), the range-wide population of the Indiana bat has declined from approximately 883,300 Indiana bats for 1960/1970 to 387,301 in 2003/2004, or approximately 56 percent. (Clawson 2002; Lori Pruitt, personal communication [a], Service). The ten-year population trend of the Indiana bat has steadily declined (Table 4).

Table 4. Ten-year, range-wide population trend for the Indiana bat.

Approximate Time period	Population Estimate	Approximate percent change
~ 1960/70	883,300	- 23
~ 1980	678,750	
~ 1980 - 1990	473,350	- 30
~ 1990 - 2000	382,350	- 19

Although a slight increase in the range-wide population was seen in the 2003/2004 data when compared to the 2001/2002 results, these results may not be statistically or biologically significant, and no determinations can be made from such a limited census period. Small fluctuations from year-to-year may be attributed to such factors as weather affecting the success of reproduction for a given year (Humphrey et al. 1977; Ransome 1990), therefore it is not appropriate to extrapolate long-term trends from changes between individual survey periods. Additionally, quality control has not been completed for this data set and therefore, it is considered preliminary.

One known major cause of Indiana bat decline has been human disturbance of hibernating bats during the decades of the 1960s through 1980s. Direct mortality has been documented due to human vandalism between the 1960s and 1980s. Some hibernacula have been rendered unavailable to Indiana bats by erection of solid gates in the entrances (Humphrey 1978). Although some hibernacula have been restored in order to support future wintering populations, and Indiana bats have returned to traditional hibernation sites, in some cases, population gains have not yet materialized. It appears that by the 1990s, vandalism and improper installation of cave gates had been reduced. Despite these efforts to reduce threats and restore traditional hibernacula, the range-wide population of Indiana bats continues to decrease. A hypothesis for population declines is that warmer winter temperatures have resulted in less conducive microhabitat conditions (warmer temperatures) at hibernacula, particularly in the southern part of the species range (Rick Clawson, personal communication, Missouri Department of Conservation).

Range-wide Maternity Colony Information

Early researchers considered floodplain and riparian forest to be the primary maternity roosting and foraging habitats used in the summer by the Indiana bat, and these forest types unquestionably are important (Humphrey et al. 1977). More recently, upland forest has been shown to be used by Indiana bats for maternity roosting (Clark et al. 1987; Gardner et al. 1991b; Callahan et al. 1997; Kiser et al. 2002; Apogee 2003); and upland forest, old fields, and pastures with scattered trees have been shown to provide maternity foraging habitat (Gardner et al. 1991b).

The first Indiana bat maternity colony was found in the Midwest region. As a result, the majority of studies of maternity colonies and their associated habitats have been conducted in glaciated regions of the Midwest region (southern Iowa, northern Missouri, northern Illinois, northern Indiana, and southern Michigan). Remaining woodlands in this glaciated region are mostly fragmented with small bottomland and upland forested tracts of predominantly oak-hickory forest types and riparian/bottomland forests of elm-ash-cottonwood associations. These forested areas exist in an otherwise agricultural dominated (non-forested) landscape (Forest Service 1997). Nevertheless, the small amount of forested area in this region appears to have a relatively high density of maternity colonies, especially when compared to the unglaciated forested landscapes similar to the action area. While the majority of maternity colonies have been discovered in the glaciated areas of the Midwest, some have been discovered as far northeast as Vermont’s Lake Champlain valley and as far south as the Nantahala National Forest in western North Carolina.

Despite the large expanse of forested habitat in the unglaciated portions of the Midwest (southern Missouri, southern Illinois, southern Indiana, and southern Ohio), Kentucky and most of the eastern and southern portions of the species’ range (including Pennsylvania and West Virginia) appears to have fewer maternity colonies per unit area of forest. However, such conclusions may be premature, given the lack of search effort and large areas of forested habitat in these areas. The recent discovery of maternity colonies in these areas has led to expanded search efforts and habitat studies.

Based on published literature and correspondence with Service or State biologists throughout the range of the Indiana bat, maternity activity has been documented at approximately 225-250 locations throughout the species’ range (Table 5) (Service 2004b). The majority of confirmed maternity areas are in the “core” of the range, in the glaciated Midwest in pockets of remaining forested habitat within a predominantly agricultural landscape in close proximity to known hibernacula. Because the Indiana bat is philopatric, there is no evidence to suggest that maternity colonies are located in optimal foraging and roosting habitat. A possible explanation for the species’ decline is that existing maternity colonies are senescent (i.e. recruitment <

death). This could be caused by pups being produced but not surviving their first hibernation period; or maternity areas are no longer providing a sufficient supply of suitable prey, resulting in an increase in the age of first reproduction and increasing fecundity schedules. Proof of at least several years of successful reproduction and recruitment would be needed to verify long-term survival of the Indiana bat in these highly altered and fragmented landscapes. Although data at a few maternity sites indicate that reproduction is occurring (exit counts nearly double a month after birth), long term monitoring of maternity sites to is limited. Long term monitoring has been conducted at a maternity colony located near the Indianapolis Airport (Indianapolis Airport Authority 2003; Indianapolis Airport Authority 2004). This colony continues to persist, and shows evidence of reproduction, although additional monitoring is needed to make a determination regarding whether the colony is stable, increasing, or decreasing the long-term at this site.

Table 5. Documented Indiana bat maternity areas (or maternity activity).

State	Number of Maternity Colonies[1]
Illinois	38
Indiana	83
Iowa	21
Kentucky	21
Michigan	10
Missouri	17
Ohio	9
Pennsylvania	1
New Jersey	1
North Carolina / Tennessee	5
Vermont / New York	7
Virginia	1
West Virginia	2
TOTAL	216 (225-250)

[1] Estimates are based on the capture of a reproductive female or juveniles in a discrete area during the maternity season (15 May – 15 August), or telemetry tracking reproductive females from hibernacula to maternity roost sites. This number is based on correspondence through the 2003 field season. In order to allow for new maternity colonies discovered in 2004, it is assumed that approximately 225-250 maternity colonies have been discovered.

Monitoring data, including extensive exit counts to estimate maternity colony population size and structure over more than one-year, is available for only a few of the approximately 225-250 maternity colonies discovered (Humphrey et al. 1977; Garner and Gardner 1992; Callahan 1993; Gardner et al. 1991b; Kurta et al. 1996; Indianapolis Airport Authority 2003; Indianapolis Airport Authority 2004). Additionally, because the vast majority of the Indiana bat maternity colonies have not been discovered, let alone studied, what little demographic data that is available, represent a fraction of the range-wide maternity activity.

Because so little is known regarding the population size and structure of maternity colonies, the Service used the same assumption as Whitaker and Brack (2002) to determine the average maternity colony size to give an approximation of the number of potential maternity colonies range-wide for the Indiana bat. The Service recognizes that maternity colonies are not static in size, and the numbers of individuals that comprise a maternity colony likely vary widely as a colony adjusts to current conditions, including the availability and quality of roosting and foraging habitat, and variable climatic conditions. Therefore, these figures should not be used to make extrapolations regarding the densities or distribution of maternity colonies present within in portions of the species range (Racey and Entwhistle 2003), however, these figure do serve to provide a rough estimation regarding the number of maternity colonies that might be present across the landscape. The "Maternity Colony Size – Population" section found in the "Life History" section of this biological opinion provides more information with regard to the size of a maternity colony.

Recognizing the inherent deficiency in such an assumption, these calculations illustrate that the vast majority of maternity colonies for the Indiana bat have not been documented (Table 6). The location of most maternity colonies may always remain unknown because of the difficulty in detecting maternity activity for the Indiana bat. This places these colonies at risk when land use practices, such as timber harvesting and development, are carried out. Therefore, another likely cause for the declining trend of this species and the level of activity occurring across the landscape is that maternity colonies are being reduced in numbers, and in some cases extirpated, prior to their discovery.

Table 6. Estimated number of Indiana bat maternity colonies range-wide.

Year	Hibernating Population	Percent Change	Number of Maternity Colonies[1]	Number of known maternity areas[2]	Percent of known maternity Colonies
1960/1970	883,300		5500	-	-
~1980	678,750	-23	4200	-	-
~1990	473,550	-31	2900	-	-
2003/2004	387,301	-18	2400	~ 225-250	~10

[1] Total rounded to the nearest 100. Estimates of the number of maternity colonies range-wide (Table 6)were developed based on the following assumptions: 1) the known hibernating population is the source of the entire summer population; 2) there is a 50:50 sex ratio (Humphrey et al. 1977); 3) average maternity colony size of 80 adult females (Whitaker and Brack 2002); and 4) the trend in decline of the total number of maternity colonies follows that of the hibernating population.
[2] This is the number of areas where reproductive females have been captured during the maternity season.

Status of Indiana Bat Habitat in the Appalachian Coalfields
The action area is located within a region underlain by coal deposits and, therefore, is subject to past, present, and future mining activities. In 2003, a number of federal agencies and the WVDEP published a Draft Programmatic Environmental Impact Statement (EIS) on mining/valley fills in Appalachia (U.S. Environmental Protection Agency 2003). The EIS study area included the coalfields of Appalachia in eastern Kentucky, southwest Virginia, southwestern West Virginia and a small portion of Tennessee, covering an area of over 12.2 million acres.

Studies conducted for the EIS anticipated significant impacts to aquatic and terrestrial habitats as a result of mining activities.

Existing and projected (10-year) future impacts are expected to total 2,400 miles of streams and 2,200 square miles of land, or 11 percent of forested habitat in the Appalachian coalfields region. Although this entire area is considered potential summer (maternity) habitat for the Indiana bat, the only confirmed maternity activity occurs on the project area that is the subject of this consultation.

Direct impacts to streams in the study area were calculated by mineral extraction area and valley fills that would result in actual destruction of existing streams. Indirect impacts to streams such as those that would occur downstream from filled or mined-out stream areas were not evaluated in the EIS. Therefore, the impacts to streams are likely underestimated. The projected potential adverse impacts in the West Virginia portion of the study area on riparian habitats are approximately 7,591 acres. In the last ten years, the study area has lost approximately 380,547 acres of forest cover as a result of coal mining. When adding past, present and future terrestrial disturbance, the total loss of forest cover will be approximately 1.4 million acres (U.S. Environmental Protection Agency 2003).

Indiana Bat Status in West Virginia

Hibernating population

The largest hibernating Indiana bat concentration in West Virginia is found in Hellhole, a Priority II hibernaculum located approximately 135 miles northeast of the action area. Approximately 8,500 of West Virginia's 10,000 known hibernating Indiana bats winter in Hellhole. A winter census of Hellhole was last conducted in February 2001.

The winter Indiana bat population trend in West Virginia, particularly at Hellhole, is much different than the range-wide population trend. From 1986 to 2001 Indiana bat populations in Hellhole have increased 157.2 percent. However, positive protection measures limiting access to the cave occurred when the entrance to Hellhole was fenced in 1985. Ultimately, bat numbers may have increased due to the decrease in winter disturbances by unfettered access by humans. Although the location of maternity colonies for bats hibernating in Hellhole is unknown, the increase in the number of hibernating Indiana bats there exceeds hypothetical growth rates based on optimistic estimates of survival and reproductive rates for this species, suggesting that immigration from other hibernacula and/or their progeny was a substantial contributor. For example, in 1996, there were about 100 bats hibernating in a reclaimed mine in Illinois according to the initial census. After installation of a bat gate and reclamation efforts, the population had increased to 9,000 by 1999; to 15,000 by 2001; and to more than 26,000 by 2003 (Chadwick 2004). Therefore, a possible explanation for the increase of hibernating bats in Hellhole is that individuals have been moving in from other hibernacula after the cave was fenced.

Maternity Activity

There have been over one hundred mist net surveys conducted throughout West Virginia over the last five years during the maternity period, which have resulted in an effort of well over 1,500 net nights. Ninety-five percent of these surveys have been conducted for project clearance. Prior to 2004, the effort had resulted in the capture of eight Indiana bats (6 males and 2 females).

The six males were captured in the following counties: Clay-1 (1999); Nicholas-1 (1999); Randolph-3 (1999,2000 and 2002 with a recapture in 2003); and Raleigh-1 (2003). The two females were captured in the action area in 2003.

Indiana bats were netted at five sites during the 2004 mist netting season (Barbara Sargent, West Virginia Division of Natural Resources, Personal Communication, 2004). Sanders Environmental, Inc. (Sanders) netted a male Indiana bat in Pocahontas County near Thornwood. A transmitter was placed on the bat and it was tracked to foraging areas, but not to a roost site. Sanders also placed transmitters on two male Indiana bats in the Reeds Creek area of Pendleton County. These bats were tracked to a roost tree, but no other bats were netted at this site. Sanders netted a lactating female Indiana Bat near Gladwin in Tucker County. This bat was fitted with a transmitter and tracked to a maternity colony with 25-30 bats. This is the second confirmed area with maternity activity in West Virginia. Apogee Environmental Consultants, LLC netted and placed a transmitter on a lactating female Indiana bat in Boone County. It was tracked to two roost trees with approximately 4 bats. It was captured in the same area as last year's Boone County capture (in the action area), which was the first confirmed maternity activity in West Virginia. Lastly, Ecological Specialties, LLC (formerly WDH Ecological Services) netted a male Indiana bat in Nicholas County near Jodie. This bat was not fitted with a transmitter.

Indiana Bat Status near the Action Area

Hibernating population

As depicted in Figure 6 and further discussed in the *Distribution* section of this document, it is not possible to predict where the Indiana bats in the action area hibernate. Nonetheless, as described in the Corps BA, the action area is relatively close to hibernacula, with the closest known hibernacula located in Greenbrier (70 miles), Mercer (52 miles), and Monroe (71 miles) counties in West Virginia (Craig Stihler, personal communication, West Virginia Division of Natural Resources); Carter (76 miles), Elliott (75 miles), and Morgan (82 miles) counties in Kentucky; Lawrence County (63 miles) in Ohio; and Bland (67 miles) and Tazewell (60 miles) Counties in Virginia (Service 2002).

Winter hibernacula counts in Greenbrier, Mercer and Monroe counties, West Virginia suggest populations have been relatively stable (with a total of approximately 34-85 Indiana bats in a given year) over the last 10 years (Table 7). However, it is difficult to compare data between years because of inconsistencies in winter caves censuses from year to year. There are two items to note for these hibernacula in West Virginia. Greenville Saltpeter Cave historically (as recent as 1952) had over 300 hibernating Indiana bats. Counts over the last fifteen have revealed a maximum of 6 hibernating Indiana bats. Also, while hibernating populations appear to persist in these counties, numbers of Indiana bats within individual hibernacula have ranged from one to 54, with none of these hibernacula having more than 60 hibernating Indiana bats in a given winter.

Table 7. Populations of hibernating Indiana bats in West Virginia closest to the action area.[2]

	Greenbrier County						Mercer County	Monroe County		
	Bob Gee Cave	General Davis Cave	Higginbothams Cave system	McFerrin Cave	Organ Cave	Piercy's Cave	Honacker Cave	Argobrites Cave	Greenville Saltpeter Cave	Patton Cave
1952				39					300+	yes
1963										8
1976	8		1	0				0		
1981	6	6, 10		2					2	3
1984	9			0						
1986		2				11, 47				
1987	6									
1989					11					
1990	3					24			3	
1991		8			12					
1992					9				2	
1993		7								
1994		7				26			1	
1998					5	50	20		3	17
1999							40			
2000		6			3	54	16		4	8
2001										
2002	0	5			11	40			6	10

[2] No entry for a cell represents no data. If surveys were conducted and no Indiana bats were documented, the value is ”0”.

The hibernating population at Newberry –Bane Cave in Bland County, Virginia has fluctuated from 90 hibernating Indiana bats in 1986 to 235 in 2000. The last count (2003) revealed 189 hibernating Indiana bats. It appears that this wintering population has been relatively stable over the last 10 years (Table 8).

Table 8. Populations of hibernating Indiana bats in Virginia (Bland County) closest to the action area[3].

Winter Survey Year	Newberry-Bane Cave
1986	90
1988	
1990	120
1992	100
1993	107
1995	110
1999	120
2000	235
2001	154
2003	189

While there are some hibernacula in Elliot, Menifee, and Morgan counties, Kentucky, the vast majority of hibernating Indiana bats within 75-miles of the action area in Kentucky are located in Carter County, especially Bat Cave, Laurel Cave and Saltpeter Cave (Table 9). The overall wintering population has declined from 35,700 in 1993 to 25,250 in 2003.

[1] No entry for a cell represents no data. If surveys were conducted and no Indiana bats were documented, the value is "0".

[3] In 1988, one Indiana bat was observed in the Hamilton Cave hibernaculum in Bland County, VA. During the 2003 winter census, 0 Indiana bats were observed in Hamilton Cave.

Table 9. Populations of hibernating Indiana bats in KY closest to the action area.[4]

	Carter County				
	Saltpeter Cave	Bat Cave	Cascade Caverns	Laurel Cave	**Total**
1980					
1981			3		3
1983	13		1		14
1987	39				39
1991					
1992					
1993		35,700			35,700
1995		31,400			31,400
1997		28,788*			28,788
1998				1,252	1,252
1999	475	25,100		912	26,487
2000			2	850	852
2001	1,225	25,000		1,225	27,550
2003	3,100	20,750		1,400	25,250

From 1996-2004, the hibernating Indiana bat population in Lawrence County, Ohio appears to be stable (Table 10).

[4] While there are hibernacula in Elliott, Menifee and Morgan counties, there were not more than 2 Indiana bats in any hibernacula in these counties during surveys. Additionally, these caves have been checked infrequently.

Table 10. Populations of hibernating Indiana bats in Ohio (Lawrence County) closest to the action area.

Survey Year	Hibernating population
1996	9,298
1998	9,292
2000	9,638
2002	9,623
2004	9,436

Maternity Activity
In addition to the two mist net surveys conducted in the action area, there have been 15 mist net surveys conducted during the maternity period in the last two years in Boone County. This has resulted in the capture of well over one thousand bats of at least seven different species in addition to the Indiana bat.

With the exception of the three reproductively active female Indiana bats caught within the action area, no other Indiana bats have been captured in Boone County. Additionally, this is the only maternity colony that has been discovered in southwestern West Virginia.

Previous Incidental Take Authorizations
Summary
All previously issued Service biological opinions involving the Indiana bat have been non-jeopardy. These formal consultations (approximately 20-25) have involved: the Forest Service for activities implemented under various different Land and Resource Management Plans on different National Forests in the eastern United States (50-75%); the Federal Highway Administration for various transportation projects (10-15%); the Corps for various water projects (5-10%); and the Department of Defense for operations at several different military installations 20-30%). Additionally, an incidental take permit has been issued under section 10 of the Endangered Species Act to an Interagency Taskforce for expansion and related development at the Indianapolis Airport in conjunction with the implementation of a Habitat Conservation Plan.

National Forests
Within the past several years, nearly all National Forests within the range of the Indiana bat have requested formal consultation in order to receive incidental take statements. This has been a result of uncertainty due to agency inability to discount the chance of take of the Indiana bat as a result of forest management activities during the non-hibernation period. Consequently, the Service has prepared non-jeopardy biological opinions and issued incidental take statements for at least fifteen different National Forests throughout the species' range. Despite incidental take

authorization for these National Forests, the confirmed loss of a maternity colony on a National Forest has never been authorized because effects to known maternity colonies have been avoided. These opinions analyzed continued implementation of each of the respective forest's Land and Resource Management Plans at the programmatic level. This established the framework to undergo formal consultation more efficiently at the project level.

Over 95 percent of previously authorized habitat loss on National Forests is not permanent loss. Rather, it is varying degrees of temporary loss (short-term and long-term) as a result of timber management activities. The analysis found in the Service's biological opinion for forest management and other activities authorized, funded, or carried out by the Mark Twain National Forest provides a thorough analysis as to the expected impacts on the Indiana bat on several different National Forests (Service 1999a). Although this analysis does not include all National Forests that have received an incidental take statement to date, the concepts of the analysis are consistent, regardless of the location. Conservation measures provided by the Forest Service as part of the proposed action, as well as reasonable and prudent measures provided by the Service to minimize the impact of the annual allowable take for each of the National Forests, have been designed to: (1) ensure an abundance of available remaining Indiana bat roosting and foraging habitat on all National Forests; and (2) ensure persistence of any known or newly discovered maternity colonies to the maximum extent practicable.

Although Indiana bat presence has been verified on most, if not all, National Forests, confirmation of maternity activity on these lands is scant. There have been less than five maternity colonies documented on National Forests. It must be noted that maternity activity was confirmed for the first time on two national forests (Monongahela National Forest [West Virginia] and Hoosier [Indiana]) in 2004.

Take has been authorized in the form of habitat loss because of the difficulty of detecting and quantifying take of the Indiana bat due to the bat's small body size, widely dispersed individuals under loose bark or in cavities of trees, and unknown spatial extent and density of their summer roosting population range within the respective National Forest. For some incidental take statements, take has also been extrapolated to include an estimated number of individual Indiana bats. The estimate of the number of individual Indiana bats likely to be taken has been wide-ranging and based on various assumptions. Legal coverage has included the take, by kill, of individual Indiana bats; or take, by harm through habitat loss, or harassment.

None of the incidental take statements referenced above have resulted in an appreciable reduction in the numbers of Indiana bats because of the nature of the loss and the conservation measures implemented in conjunction with the proposed action.

Other Federal Agencies or Non-federal Entity

Several incidental take statements (e.g., construction of a reservoir involving the Corps in Marion, Illinois [Service 1995]; Fort Knox military operations [Service 1999c]; Camp Atterbury military operations [Service 1998]; Newport Military Installation [Service 1999d]; I-69 Highway [Service 2003]) and an incidental take permit (e.g. Six Points Road Interchange) have been issued to other federal agencies and a non-federal entity, respectively. These projects actually involved impacts to known maternity colonies. In other words, there was at least one known maternity colony within the action area of the project. For these projects (with the exception of Fort Knox; see below), conservation measures, included as part of the proposed action, were designed to minimize impacts to the colony with the goal of ensuring persistence of the colony after implementation of the project. These measures included: seasonal clearing restrictions to avoid disturbing female Indiana bats and young; protection of all known primary and alternate roost trees with an appropriate buffer; retention of adequate roosting and foraging habitat to sustain the maternity colony into the future; and permanent protection of areas and habitat enhancement or creation measures to provide future roosting and foraging habitat opportunities. With the exception of Fort Knox, none of these biological opinions and associated incidental take statements have authorized or otherwise resulted in the loss of a maternity colony. There are three examples in Indiana (Camp Atterbury, Newport Military Installation, and Indianapolis Airport) where monitoring has confirmed that the colony persisted through the life of the project and continues to exist today. However the full extent of the anticipated impacts may not yet have occurred and overall population trends are difficult to discern. While several other biological opinions have been prepared with the same ultimate goal of maintaining colony persistence, project implementation is not complete. The Fort Knox biological opinion [1999] did authorize the loss of two potential maternity colonies and 8 Indiana bats, although Indiana bat maternity activity had not been confirmed in the action area. In subsequent surveys, maternity activity was confirmed in two different areas at Fort Knox. The Fort Knox biological opinion [1999] did authorize the take of two maternity colonies and 8 Indiana bats, although Indiana bat maternity activity had not been confirmed in the action area. The biological opinion did not specify whether the "take" consisted of loss of the colonies or take in the form of harm and harassment.[5] In subsequent surveys, maternity activity was confirmed in two different areas at Fort Knox. A biological assessment was prepared by the Army that outlined that known roost trees would be cut and bats would be displaced from the habitat. The BA also proposed conservation measures that included seasonal clearing restrictions to avoid disturbing female Indiana bats and young; retention of some known roost trees; maintaining riparian buffer zones around waterways; creation and retention of snags; permanent protection of adjacent areas to provide sufficient habitat to support Indiana bat foraging and roosting; and monitoring of colonies in the area. However, the Service has been unable to locate any records of monitoring being conducted after construction of the project.

INDIANA BAT LIFE HISTORY

Colonial roosting behavior and site fidelity are two important features of Indiana bat behavioral biology to consider when analyzing the effects of the loss of confirmed Indiana bat maternity habitat. These behaviors allow the Indiana bat to maximize reproduction opportunities given the reproductive limitations of this species (healthy females are capable of producing only one pup per year, even under ideal circumstances).

[5] "Harm" in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" in the definition of take means an intentional or negligent act or omission which creates the likelihood of injury to wildlife annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

The Latin name “sodalis” means social and accurately portrays the social nature of the Indiana bat. Indiana bats exhibit colonial behaviors in virtually every stage of their life history. Such colonial traits may substantially affect both survival and productivity. Maintenance of functional colonies with relatively large numbers of bats may be critical to thermoregulation at both the hibernaculum and the maternity colony. It is probable that bat aggregation during winter hibernation helps minimize the metabolic cost of thermoregulation during hibernation. Another social aspect to clustering behavior occurs when the same individuals return yearly to not only the same cave, but often to the same discrete area of the cave ceiling (Craig Stihler, personal communication). During work in Indiana at a major Indiana bat hibernacula, towards the end of the hibernation season, several bats appeared to warm up just long enough to move to the nearest cluster when the departure of their cohorts left them alone. What ever social benefit Indiana bats derive from their clustering behavior seems to be very important to them (Lori Pruitt, personal communication [b], Service). Swarming prior to hibernation may play a role in the detection and/or attraction of mates, so that low numbers of Indiana bats result in lower rates of successful mating even at mixed-species hibernacula where overall bat numbers (all species) are sufficient for thermoregulation. Migration for any species is considered to be a vulnerable life stage. The Indiana bat is no exception, particularly: in the spring when fat reserves are low; over long-distances; or for juveniles migrating for the first time in the fall. While it is not known, successful migration for the Indiana bat may depend on large numbers of conspecifics using the same routes at the same time.

Reproductively active females return to and congregate at maternity colonies to give birth and raise their young. While very little is known about the social structure of these colonies, these groupings may allow for better thermoregulation, predator avoidance, and foraging efficiency. Research has shown that members of the colony may communicate regarding foraging areas (Murray and Kurta 2004). Thermoregulation provides a physiological advantage to the raising of a pup. When lactating adult female Indiana bats and pups congregate, both expend less energy. Therefore, more energy can be expended on nurturing the pups and enabling their young to achieve maturity faster.

As will be discussed in the “Effects of the Action” section, this dynamic of social interactions and loyalty to a specific summer habitat area are key factors to consider when evaluating the viability of maternity colonies affected by the proposed action.

Life Cycles

The Indiana bat’s annual life cycle consists of hibernation, spring migration, birthing (parturition), raising of young by females (lactation), fall migration, mating (swarming), and hibernation. Each of these critical stages in this complex annual reproductive cycle is integral to species survival and recovery (Figure 3). While the following information provides a general overview of the life cycle of the Indiana bat, the “Life Stages” section provides additional information.

During winter, Indiana bats are restricted to suitable hibernacula (mostly caves, but also a few abandoned mines, and even a tunnel and hydroelectric dam) that are located primarily in karst areas of the east-central United States. Hibernation facilitates survival during winter when prey (i.e., insects) are unavailable. Indiana bats cluster and hibernate on cave ceilings in densities of approximately 300-484 bats per square foot. Clusters may protect central individuals from temperature change and reduce sensitivity to disturbance.

During spring, Indiana bats emerge from hibernacula and move to their summer habitat. Females can migrate hundreds of miles from their hibernacula. Kurta and Murray (2002) documented female Indiana bats migrating over 200 miles from their hibernacula to their maternity area and Gardner and Cook (2002) documented migratory distances in excess of 300 miles for females traveling from hibernacula to maternity areas. Some male Indiana bats have been documented to remain near hibernacula throughout the summer, while other males have been captured throughout various summer habitats. Female bats from different hibernacula are known to navigate to maternity sites (Kurta and Murray 2002), at least in part by physical cues on the landscape. Several species of North American bats, including the Indiana bat, show high fidelity to maternity roosts (Kurta and Murray 2002). Females form maternity colonies with other females to give birth and raise young. Migration is stressful for pregnant Indiana bats when their fat reserves and food supplies are low. In the northeastern part of their range, female Indiana bats may migrate shorter distances in order to maximize energy reserves by arriving at their summer habitat quickly.

After grouping into maternity colonies, females give birth to a single young in June or early July (Easterla and Watkins 1969, Humphrey et al. 1977). As will be further discussed, colonial behavior is well documented for females at maternity colonies. This life history strategy reduces thermoregulatory costs, which, in turn increases the amount of energy available for birthing and the raising of young (Barclay and Harder 2003). Studies by Belwood (2002) show asynchronous births among members of a colony. This results in great variation in size of juveniles (newborn to almost adult size young) in the same colony. In Indiana, lactating females have been recorded from June 10 to July 29 (Whitaker and Brack 2002). Young Indiana bats are capable of flight within a month of birth. Young born in early June may be flying as early as the first week of July (Clark et al. 1987), others from mid- to late July.

Indiana bats begin to return to their respective hibernacula as early as August. Females from the same maternity colony do not necessarily go to the same hibernaculum. Breeding takes place and fat reserves are replenished as bats congregate at hibernacula and prepare for hibernation. A particular ratio of fat to lean mass is normally necessary for puberty and the maintenance of female reproductive activity in mammals (Racey 1982). Racey (1982) suggests that the variation in the age of puberty in bats is due to nutritional factors, possibly resulting from the late birth of young and their failure to achieve threshold body weight in their first autumn. Additionally, once puberty is achieved, reproductive rates frequently reach 100 percent among healthy bats of the family Vespertilionidae, as is the Indiana bat (Racey 1982). Limited data suggest that young, healthy female bats can mate in their first autumn so long as their prey base is sufficient to allow them to reach a particular fat:lean mass ratio (Racey 1982). Limited mating activity occurs throughout the winter and in late April as the bats leave hibernation (Hall 1962).

General Roosting Behavior

While roosting behavior specific to the various life stages of the Indiana bat is discussed in the "Maternity colony – roost tree selection" section, the following information provides a general overview of Indiana bat roosting behavior. Within the range of the species, the existence of

Indiana bats in a particular area may be governed by the availability of natural roost structures, primarily standing dead or live trees with loose bark (Carter 2003; Kurta et al. 2002; Kurta et al. 1993a; 3D/E 1995; Gardner et al 1991b). The suitability of any tree as a roost site is determined by 1) its condition (dead or alive); 2) the quantity of loose bark; 3) the tree's solar exposure and location in relation to other trees; and 4) the tree's spatial relationship to water sources and foraging areas. Indiana bats utilize interstitial spaces within trees, or parts of trees as roost sites. For example, the following have been documented as providing roosts for Indiana bats: tree cavities or hollow portions of tree boles (Gardner et al. 1991a**;** Kurta et al. 1993b); a crevice in the top of a lightning-struck tree (Gardner et al. 1991a); and splits below splintered, broken tree tops (Kurta, et al. 1996; Callahan et al. 1997; Gardner et al. 1991b; Garner and Gardner 1992).

Morphological characteristics of the bark of a number of trees make them suitable as roosts for Indiana bats; that is, when dead, senescent, or severely injured (e.g., lightning-struck) the trees possess bark that springs away from the trunk upon drying. Additionally, the shaggy bark of some living hickories (*Carya* spp.) and large white oaks (*Quercus alba*) also provide roost sites. The most important characteristics of trees that provide roosts are not species but structure: exfoliating bark with space for bats to roost between the bark and the bole of the tree. The length of persistence of peeling bark varies with the species of tree and the severity of environmental factors to which it is subjected. Tree species reported to be used as roosts by Indiana bats include: American beech (*Fagus grandifolia*), ashes (*Fraxinus* spp.), black gum (*Nyssa sylvatica*), black locust (*Robinia pseudo-acacia*), cottonwood (*Populus deltoides*), elms (*Ulmus* spp.), hickories, maples (*Acer* spp.), oaks (*Quercus* spp.), pines (*Pinus* spp.), sassafras (*Sassafras albidum*), sourwood (*Oxydendrum arboreum*), sweet birch (*Betula lenta*), and yellow buckeye (*Aesculus octandra*) (Cope et al. 1978; Humphrey et al. 1977; Gardner et al. 1991a, b; Garner and Gardner 1992; Kurta et al. 1993a; 3D/E 1995; Kiser and Elliott 1996; Kurta et al. 1996; Callahan et al. 1997).

General Foraging Behavior

While foraging behavior specific to the various life stages of the Indiana bat is discussed in the “Non-reproductive females and males” and “Maternity Colony foraging behavior” sections, the following information provides a general overview of Indiana bat foraging behavior. Because most Indiana bats caught in mist-nets are captured over streams and other flyways at heights greater than 6 ft (2 m) (Gardner et al. 1989), it is believed that Indiana bats usually forage and fly within an air space from 6 - 100 ft (2 - 30 m) above ground level (Humphrey et al. 1977).

Indiana bats feed solely on emerged aquatic and terrestrial flying insects (Brack and LaVal 1985; Kurta and Whitaker 1998; Belwood 1979; Service 1983). They are habitat generalists and their selection of prey items reflects the environment in which they forage (LaVal and LaVal 1980). Because of the large and variable distribution of the Indiana bat (Gardner and Cook 2002; Brack et al. 2002; also see Figure 2), it is not surprising that differences in foraging habitat have been recorded between different parts of the summer range, or between bats on the maternity range and near hibernacula. For example, in the southern part of the range, terrestrial-based prey (moths and beetles) are more common. This may be a result of Indiana bats predominantly foraging near treetops in these areas (Brack and LaVal 1985). In the northern region where foraging areas are more limited to riparian zones, aquatic-based prey dominate the diet. Diet varies seasonally and variation is observed among different ages, sexes, and reproductive-status groups (Belwood 1979). It is probable that Indiana bats use a combination of both selective and opportunistic feeding to their advantage (Brack and LaVal 1985). Reproductively active females and juveniles exhibit greater dietary diversity than males and non-reproductively active adult females, perhaps due to higher energy demands. Studies in some areas have found that reproductively active females eat more aquatic insects than do juveniles or adult males (Kurta and Whitaker 1998), this may be the result of habitat differences (Brack and LaVal 1985). Differences in habitat availability and competition with other species may be two explanations for such seasonal or geographic differences in selection of foraging habitat (Sparks el al. in press). Preliminary analysis of data collected in Pennsylvania (Butchkoski and Hassinger 2002), in Missouri (Romme' et al. 2002) and Indiana (Sparks et al. in press) show no clear association between size of foraging area and sex, age, or reproductive class (Sparks et al. in press). It is apparent that Indiana bats show fidelity to foraging areas between years by bats in different reproductive classes (Sparks et al. in press).

Moths (Lepidoptera) are major prey items identified in several studies (Belwood 1979; LaVal and LaVal 1980; Brack and LaVal 1985), but caddisflies (Trichoptera) and flies (Diptera) are also documented (Kurta and Whitaker 1998). A fourth major prey group includes mosquitoes and midges (Belwood 1979; Whitaker 2004), especially species that form large mating aggregations above or near water (Belwood 1979). Other prey include bees, wasps, and flying ants (Hymenoptera), beetles (Coleoptera), leafhoppers (Homoptera), treehoppers (Homoptera), stoneflies (Plecoptera), and lacewings (Neuroptera) (Whitaker 1972; Belwood 1979; Whitaker 2004). Caddisflies are irregularly available, but are apparently highly desirable for many bat species, since they appear to be preferentially eaten when available (Whitaker 2004). This trend may also be true of other aquatic insects that have concentrated emergences. Brack and LaVal (1985) examined fecal pellets of 140 male Indiana bats and identified 83 percent of the prey items from taxa from the genera Lepidoptera and seven percent as Coleoptera.

Drinking water is essential when bats actively forage. Throughout most of the summer range, Indiana bats frequently forage along riparian corridors and obtain water from streams. However, natural and anthropogenic ponds and water-filled road ruts in the forest uplands are also very important water sources for Indiana bats in these regions.

Longevity

Mortality between birth and weaning has been estimated at eight percent (Humphrey et al. 1977). Humphrey et al.(1977) determined that female survivorship in an Indiana population of Indiana bats was 76 percent for ages one to six years, and 66 percent for ages six to 10 years; for males, survivorship was 70 percent for ages one to six years, and 36 percent for ages six to 10 years. The maximum ages for banded individuals were 15 years for females and 14 years for males. There is limited data available regarding current survival rates, or rates previously experienced by other groups of Indiana bats.

Life Stages

As previously summarized, the Indiana bat's annual life cycle of hibernation**,** spring migration**,** parturition**,** lactation**,** fall migration, mating**,** and hibernation is further discussed below and illustrated in Figure 3.

Winter Hibernation
A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas) (Hall 1962; LaVal and LaVal 1980), but hibernacula populations may increase throughout the fall and even into early January (Clawson et al. 1980). Generally, Indiana bats hibernate from October through April (Hall 1962; LaVal and LaVal 1980), depending upon local weather conditions. They hibernate in large, dense clusters, ranging from 300 bats per square foot (Clawson et al. 1980) to 484 bats per square foot (Clawson et al. 1980). While it is generally accepted that Indiana bats, especially females, are philopatric to hibernacula, meaning they return annually to the same hibernation site, (LaVal and LaVal 1980), populations in several hibernacula have doubled between subsequent surveys (two years). As described in the *Indiana Bat Status in West Virginia* section, this is evidence that individuals do change hibernacula occasionally.

Indiana bats must store sufficient fat to support metabolic processes until spring. Substantial risks are posed by events (e.g., human disturbance) during the winter that interrupt hibernation and increase metabolic rates, potentially leading to starvation.

The Indiana bat requires specific roost sites in caves or mines that attain appropriate temperatures for hibernation (Tuttle and Taylor 1994). In southern parts of the bat's range, hibernacula trap large volumes of cold air and the bats hibernate where resulting rock temperatures drop; in northern parts of the range, however, the bats avoid the coldest sites. In both cases, the bats choose roosts with a low risk of freezing. Ideal sites are 50^{o} F or below when the bats arrive in October and November. Early studies identified a preferred mid-winter temperature range of 39-46^{o} F, but a recent examination of long-term data suggests that a slightly lower and narrower range of 37-43^{o} F may be ideal for the species (Hall 1962; LaVal and LaVal 1980; LaVal et al. 1976). Only a small percentage of available caves provide for this specialized requirement. Stable low temperatures allow the bats to maintain a low rate of metabolism and conserve fat reserves through the winter, until spring (Humphrey 1978; Richter et al. 1993). Indiana bats will occasionally use sites other than caves or mines if microclimate conditions are favorable. Kurta and Teramino (1994) found a single Indiana bat roosting with a large colony of 15,000 bats (mostly little brown and northern long-eared bats) at a hydroelectric dam in Manistee County, Michigan, and noted that the temperature was about 40.5° F.

Relative humidity at roost sites during hibernation usually is above 74 percent, but below saturation (Hall 1962; Humphrey 1978; LaVal et al. 1976; Kurta and Teramino 1994), although relative humidity as low as 54 percent has been observed (Myers 1964). Humidity may be an important factor in successful hibernation (Thomas and Cloutier 1992).

Specific cave configurations determine temperature and humidity microclimates, and thus suitability for Indiana bats (Tuttle and Stevenson 1978; LaVal and LaVal 1980). Indiana bats select roosts within hibernacula that best meet their needs for cool temperatures; in many hibernacula, these roosting sites are near an entrance, but may be deeper in the cave or mine if that is where cold air flows and is trapped (Tuttle and Stevenson 1978; Hall 1962; LaVal and LaVal 1980). Indiana bats often hibernate in the same hibernacula with other species of bats, and are occasionally observed clustered with or adjacent to other species, including gray bats (*M.*

grisescens), Virginia big-eared bats (*Plecotus townsendii virginianus*), little brown bats, and northern long-eared bats (Myers 1964; LaVal and LaVal 1980; Kurta and Teramino 1994).

Spring Emergence/Migration

Female Indiana bats emerge first from hibernation in late March or early April, followed by the males (Hall 1962). The timing of annual emergence may vary across their range, depending on latitude and annual weather conditions; however, most Indiana bats have left their hibernacula by late April (Hall 1962). Indiana bats in the Barton Hill Mine hibernaculum in northeastern New York have been observed to move in clusters towards the entrance as they ready for emergence in early April. During a two-year radio-telemetry study for spring emerging Indiana bats, (Susi von Oettingen, personal. Communication, Service) observed little cluster activity in the hibernaculum on April 1; however, by April 9 clusters were observed near the mine entrance and general emergence was estimated to occur within the week. By the end of April no clusters were observed near the entrance and it was assumed most females had left. Males have been observed leaving as late as the end of May in the same hibernaculum (Susi von Oettingen, personal communication). Approximately 200 miles south of the Barton Hill Mine, at the Mt. Hope mine complex in New Jersey, peak spring emergence of females was documented in early April. No females were captured in mid-April and only a single female was captured at the end of April. Emergence of males peaked at the end of April (Service 2000). Exit counts from several hibernacula in southern Pennsylvania and Big Springs Cave in Tucker County, West Virginia, suggest that peak emergence from hibernation is mid-April for these two areas (Butchkoski and Hassinger 2002; Mark Ford, personal communication).

Indiana bats offset the process of mating from that of gestation through delayed fertilization (Kurta in press). Shortly after emerging from hibernation, females become pregnant via delayed fertilization from sperm stored in their reproductive tracts through the winter (Hall 1962; Cope and Humphrey 1977; LaVal and LaVal 1980; Ransome 1990). The period after hibernation but prior to spring migration is typically referred to as “staging.” During this staging period, which can last for as little as one day or as long as a few weeks, most female Indiana bats emerge, and forage near their hibernaculum before migrating to their previous summer roosting (maternity) areas to give birth and raise young. Data collected during a two-year study tracking spring emerging females to their summer roost sites in the Lake Champlain valley of New York and in a separate Vermont study suggest that females do not remain in the area surrounding the hibernacula after emerging from hibernation, but leave for summer habitat soon after emergence from hibernation (Britzke et al. 2004).

Data indicate that the area within an approximate 5-mile radius of a hibernaculum is important foraging and roosting habitat for the Indiana bat at the time of spring emergence (staging) and prior to hibernation (swarming), although males have been found almost 10 miles from the hibernacula in Indiana (U.S.D.A 2000). Indiana bat tree roosts used in the spring and fall are similar in physical structure to those selected during the summer.

Little or no information is available to determine habitat use and needs for the Indiana bat during migration. In the core of their range, most pregnant Indiana bats migrate north for the summer (Gardner and Cook 2002). In the northeastern part of their range, Indiana bats may migrate in other directions. In the Lake Champlain valley of New York and Vermont, female Indiana bats migrated east and southeast to their summer habitat. In Pennsylvania, Indiana bats migrated south-southwest to their summer habitat (Butchkoski and Hassinger 2002). In general, a stronger homing tendency has been observed along a north-south axis, rather than east-west (Gardner and Cook 2002; NatureServe 2004).

Females dispersing from a Kentucky hibernaculum in the spring moved 4-10 miles within 10 days of emergence, eventually traveling more than 300 miles from the hibernaculum to the maternity area (Gardner et al. 1996; Gardner and Cook 2002). However, maternity colonies have been also located within 10 to 25 miles of the hibernaculum (Butchkoski and Hassinger 2002; Britzke et al. 2004). As previously discussed, migration is stressful for pregnant Indiana bats, particularly in the spring when their fat reserves and food supplies are low. In the northeastern part of their range, female Indiana bats may migrate shorter distances in order to maximize energy reserves by arriving at their summer habitat quickly. (Britzke et al. 2004).

Colder spring temperatures in the northeast may force the bats into temporary torpor, although some females were observed switching roosts when nighttime temperatures were below freezing. Cold temperatures may also increase the likelihood of mortality. Adult mortality may be highest in late March and April (Tuttle and Stevenson 1977). Springtime temperatures were unusually cold during a 2002 spring emergence study in New York, and two Indiana bats were found dead in or near their roosts (Britzke et al. 2004).

Less is known about the male migration pattern, but many males summer near the hibernacula (Whitaker and Brack 2002). Some males disperse throughout the range and roost individually or in small numbers in the same types of trees and in the same areas as females.

Summer

Non-reproductive Females and Males

Upon emergence from hibernation in the spring, some adult male Indiana bats form colonies in caves in summer, but most are solitary and roost in trees. Males remaining near hibernacula roost and forage in mature forest. Movements of 2.5-10 miles have been reported in Kentucky, Missouri, and Virginia (Gumbert et al. 2002; Hobson and Holland 1995; 3D/International 1996). Other males leave the area entirely. Regardless, roosting habitat for non-reproductive females and males is similar to that used by maternity colonies (Gardner et al. 1991b). The exception is that these solitary individuals are not as selective in trees used for roosting as that of reproductively active females attempting to rear young (e.g., they may use smaller trees with fewer crevices, less exfoliating bark, etc.), largely because of their disassociation from raising young.

During summer, male Indiana bats that remained near their Missouri hibernacula flew cross-country or upstream toward narrower, more densely wooded riparian areas during nightly foraging bouts, perhaps due to interspecific competition with gray bats. Some male bats also foraged at the edges of small floodplain pastures, within dense forest, and on hillsides and ridgetops; maximum reported distance was 1.2 miles (LaVal et al. 1976; LaVal et al. 1977; LaVal and LaVal 1980). In Kentucky, MacGregor reported that the maximum distance males moved from their hibernaculum in the summer was about 2.6 miles (Menzel et al. 2001). In the fall, male Indiana bats tend to roost and forage in upland and ridgetop forests, but may also forage in valley and riparian forest; movements of 1.8 - 4.2 miles have been reported in Kentucky and Missouri (Kiser and Elliott 1996; 3D/International 1996).]

Maternity Colony

Overview

Females form maternity colonies with other females to give birth and raise young. Females may arrive in their maternity habitat as early as April 15 in Illinois (Gardner et al. 1991a, Brack 1983). Work in the Lake Champlain valley of Vermont and New York showed similar results (Britzke et al. 2004). Indiana bats were found at known maternity areas by March 29 at a site in Indiana (John Whitaker, personal communication, Indiana State University). Humphrey et al. (1977) determined that Indiana bats first arrived at their maternity roost in early May in Indiana, with substantial numbers arriving in mid-May.

While there has been extensive effort to study the roosting ecology of the Indiana bat during the maternity season (May 15 – August 15), data on spring (April 1 – May 15) roosting in maternity areas are limited. One recent study was conducted in the Lake Champlain valley of Vermont and New York (Britzke et al. 2003) where one or more spring roosts were identified for 15 radio-tagged females. During emergence counts of roost trees occupied by the radio-tagged female bats, additional untagged bats were seen emerging from adjacent trees on a number of occasions (Britzke et al. 2004). Data from this work and studies conducted in Indiana suggest that some female Indiana bats start congregating in the same area and eventually form a primary maternity area, or roost, by early to late April (Indiana Airport Authority 2004; Britzke et al. 2003; Britzke et al. 2004;). Follow-up surveys confirmed the presence of maternity colonies at three of four spring roost sites. Moreover, based on analysis of summer roosts from the Lake Champlain valley, and other roost tree data, Britzke et al. (2003) determined that spring roost trees were similar in structure and characteristics to those used during summer (trees with exfoliating bark and high sun exposure).

After grouping into maternity colonies, females give birth to a single young in June or early July (Easterla and Watkins 1969, Humphrey et al. 1977). This life history strategy reduces thermoregulatory costs, which, in turn increases the amount of energy available for birthing and the raising of young (Barclay and Harder 2003). There are no documented occurrences in which a female Indiana bat has successfully given birth and raised a pup alone without the communal benefits, particularly thermoregulation, offered by establishment of a maternity colony. As will be further discussed, colonial behavior is well documented for females at maternity colonies. Studies by Belwood (2002) show asynchronous births among members of a colony. This results in great variation in size of juveniles (newborn to almost adult size young) in the same colony. In Indiana, lactating females have been recorded from June 10 to July 29 (Whitaker and Brack 2002). Young Indiana bats are capable of flight within a month of birth. Young born in early June may be flying as early as the first week of July (Clark et al. 1987), others from mid- to late July.

Roosting ecology of the Indiana bat when young become capable of flight (early to late July) is similar to behavior in the early summer. However, the maternity colony begins to disperse and use of primary maternity roosts diminishes, even though bats stay in the area prior to migrating back to their respective hibernacula. Bats become less gregarious and the colony utilizes more alternate roosts, possibly because there is no longer the need for the adult females to cluster to thermoregulate and nurture the young (Indianapolis Airport Authority 2003 and 2004).

Indiana bats spend the latter part of the summer accumulating fat reserves for fall migration and hibernation. Indiana bats begin to return to their respective hibernacula as early as August. Females from the same maternity colony do not necessarily go to the same hibernaculum. A particular ratio of fat to lean mass is normally necessary for puberty and the maintenance of female reproductive activity in the mammals (Racey 1982). Racey (1982) suggests that the intrasexual variation in the age of puberty in bats is due to nutritional factors, possibly resulting from the late birth of young and their failure to achieve threshold body weight in their first autumn. Additionally, once puberty is achieved, reproductive rates frequently reach 100 percent among bats of the family Vespertilionidae, as is the Indiana bat (Racey 1982). Limited data suggest that young, healthy female bats can mate in their first autumn so long as their prey base is sufficient to allow them to reach a particular fat:lean mass ratio Racey 1982). Limited mating activity occurs throughout the winter and in late April as the bats leave hibernation (Hall 1962).

Social Structure

The following information describing a fission-fusion society is taken directly from Barclay and Kurta (in press):

> Recurrent roost switching and fluctuating composition of the group at any particular tree suggest the existence of a fission-fusion society (Kurta et al. 2002). In this type of society, members frequently coalesce to form a group (fusion), but composition of that group is in perpetual flux, with individuals frequently departing to be solitary or to form smaller groups (fission) for a variable time before returning to the main unit. Individuals often preferentially associate with some members of the larger group and may even avoid associating with other members.
>
> This type of flexible social organization is common among cetaceans (Conner 2000) and primates (McGrew et al. 1996; Terborgh and Janson 1986) but also occurs in other mammals, such as spotted hyenas (*Crocuta crocuta*—Holekamp et al. 1997) and kinkajous (*Potos flavus*—Kays and Gittleman 2001). In whales, all individuals in the society are members of a pod, and in hyenas, this society is termed a clan; in bats, however, members of the fission-fusion society collectively form what biologists historically have called the "colony." Although many members of a colony may reside in one tree at any one time, other members roost elsewhere as solitary individuals or in small subgroups of fluctuating composition. Such a fission-fusion society has been suggested for a few species of forest bat (Kerth and König 1999; O'Donnell 2000; Kurta et al. 2002; Willis and Brigham 2004), and further research may show that this type of social organization is common.

For example, research has shown that members of the colony may communicate regarding foraging areas (Murray and Kurta 2004). Short bouts of solitary night roosting by an individual may also serve to allow assessment of potential day roosts. In Michigan, when a tree used by maternity a colony the year before had fallen over, many bats of the colony shifted the center of their activity to a new tree approximately 2 km away that had previously been used as a night roost by a single animal bearing a transmitter the summer before (Kurta et al. 2002). As a result of colonial roosting behavior, thermoregulation provides a physiological advantage to the raising of a pup. When lactating adult female Indiana bats and pups congregate, both expend less energy. Therefore, more energy can be expended on nurturing the pup and enabling the young to achieve maturity faster.

Colonial Roosting Behavior

A capture of a reproductive (pregnant, lactating or post-lactating) female indicates that a colony of females is in the area because Indiana bats are obligate colonial roosters (Humphrey et al. 1977; Clark et al. 1987; Gardner et al. 1996, Britzke 2002). This means female bats congregate together to raise their young. Maternity colonies must have some special meaning for bats because "...animals travel to the colony from a wide geographical area and stubbornly persist in returning to the same nursery roost for decades" (Neuweiler 2000).

Colonial behavior is well documented for females at maternity colonies. As presented at a recent symposium regarding forest-dwelling bats, Barclay and Kurta (2004) suggested four potential explanations to cause female aggregation (establishment of maternity colonies) in the summer: (1) roosts are limited; (2) foraging efficiency – members of a colony communicate regarding good foraging areas; (3) anti-predator mechanism; and (4) thermoregulation. Although there are probably many advantages to colonial roosting, the likely most important factor for Indiana bats is for the thermoregulatory benefits (Humphrey et al. 1977; Kurta et al. 1996). Support for this is that pups and adults in late pregnancy are poor thermoregulators (Speakman and Thomas, 1983), and pre- and postnatal growth is controlled by rate of metabolism and body temperature (Racey 1982). Without clustering together, the strict thermal conditions needed to support prenatal and postnatal growth would not be available. Thus, colonial roosting is a life history strategy adopted by Indiana bats (like many other temperate zone bats) to improve their reproductive success (Barclay and Harder 2003). There may be a loss of these communal benefits below a threshold colony size (Racey and Entwistle 2003). While the relationship between viable population size and species colonality is poorly understood, it is an important component of their behavior (Racey and Entwistle 2003; Callahan 1993; Gardner et al. 1991b).

Site Fidelity

Indiana bats exhibit site fidelity to their traditional summer maternity and foraging areas. This life history strategy is thought to provide an advantage to the Indiana bat by increasing the probability of successfully reproduction. In turn, site fidelity may also inhibit the ability of Indiana bats to pioneer new areas (Sparks *in* Service 2004c). This concept of philopatry is based on the documentation of female Indiana bats returning to the same general area to establish maternity colonies from year-to-year (Humphrey et al. 1977; Gardner et al. 1991a, b; Callahan et al. 1997; Indianapolis Airport Authority 2003, 2004; Kurta and Murray 2002; Butchkoski and Hassinger 2002; Gardner et al. 1991a, Gardner et al. 1996) and the same roost tree so long as that tree is available, given the ephemeral nature of the roost trees. It is recognized that due to the ephemeral nature of roosting sites, site fidelity is not limited to specific trees. Instead, Indiana bats also exhibit site fidelity to their general maternity roosting and foraging areas (Rick Clawson, personal communication, Missouri Department of Conservation; Kurta in press).

Available data supports the hypothesis that individual Indiana bats are faithful to their foraging areas between years. Gardner (1991a; 1991b) observed that females returned to the same foraging areas between years regardless of whether these bats were initially captured as juveniles and then studied again as adults, or if these bats were adults during both seasons they were tracked. In Michigan, Indiana bats have been recaptured and tracked to the same sites where they were initially captured (Kurta and Murray 2002; Murray and Kurta 2004). At the Indianapolis Airport, data has been collected for the same bat in two different years on one occasion. Roosting and foraging habitat were remarkably consistent between years including occasional nocturnal visits to a day roost on the opposite end of the colony's foraging range, despite the fact that the bat was pregnant when tracked in 2003 and lactating in 2004 (Sparks et al. in press). Additionally, 43 bats have been tracked at the Indianapolis Airport between 1997 and 2004; all these bats foraged in the same general areas, although home ranges were distinct (Sparks et al. in press). In this ongoing study, bats have been found to move through their foraging habitat so predictable that researchers have been able to move into an area prior to the bat arriving (Sparks et al in press). According to discussions at a recent meeting (Service 2004c), Kurta has experienced the same situation.

Gumbert et al. (2002) differentiated between roost tree and roost area fidelity in Indiana bats, and found that bats are faithful to both areas and particular trees within those areas. Indiana bats also show a high degree of site fidelity to foraging ranges. Kurta and Murray (2002) documented recapturing 41 percent of females when mist netting at the same area in subsequent years. Indiana bat maternity colonies in Illinois, Indiana, Michigan, and Kentucky have been shown to use the same roosting and foraging areas year after year (Gardner et al. 1991b; Humphrey et al. 1977; Kurta and Murray 2002; Kurta et al. 1996, 2002). Telemetry studies of a maternity colony in Indiana have shown that bats are still returning to areas that were formerly part of their foraging range even after those areas are cleared and in industrial use (John Whitaker, personal communication). Roosting/foraging area fidelity may serve to maintain social interactions between members of the population. Bats using familiar foraging and roosting areas may have decreased susceptibility to predators and increase foraging efficiency, as well as the ability to switch roosts in case of emergencies or alterations surrounding the original roost (Gumbert et al. 2002).

Due to the ephemeral nature of their roost trees, so long as adequate roosting opportunities are available in the general area, bats are probably not dependant on the continued suitability of a specific tree. There is evidence that colonies are able to relocate after the loss of a roost tree. In Michigan, the focal point of a colony's maternity activity shifted 1.24 mile over a three-year period after the primary roost tree fell down. The area that they shifted to had been previously used by a single radio-tracked female for roosting during the summer prior to loss of the roost tree (Kurta et al. 2002). This is consistent with a number of other situations, where the bats moved to nearby roosts but retained the same commuting corridors and foraging areas once a primary roost tree of a maternity colony had been lost, (Humphrey 1977; Service 2002).

The notion of site fidelity is not accepted by all Indiana bat experts (Service 2004c; see also "Bat Movements Among Maternity Roosts" section) and some suggest that Indiana bats do not exhibit site fidelity in parts of their range (Currie *in* Service 2004c; Clawson *in* Service 2004c). Some experts suggest that maternity colonies have vanished from one year to the next (MacGregor *in*

Service 2004c) despite no apparent changes to the maternity habitat. In other words, survey efforts in subsequent years after confirmation of Indiana bat presence, have failed to capture Indiana bats in the same area. A summary of some these instances are presented below.

On the Wayne National Forest in southern Ohio, four reproductive female Indiana bats were captured during a presence-absence survey for the species (Kiser and Bryan 1997). While the Service has not received any reports (Angela Zimmerman, personal communication, Service), it has been suggested that there were intensive efforts the following year with no Indiana bats captured (MacGregor, personal communication, Kentucky Department of Fish and Wildlife Resources). At Blevins Valley in Bath County Kentucky, presence of a maternity colony was documented in 2000 (East Kentucky Power Cooperative 2000), but no Indiana bats were captured during limited efforts (one night of netting) in 2001 (Joe Settles, personal communication, East Kentucky Power Cooperative). Also, according to personal communication with John MacGregor, the following year, the roost tree was not used, and no Indiana bats could be caught or recorded (Anabat II). On the south half of the Cherokee National Forest in Tennessee, a reproductive female Indiana bat was captured. The following year, the area was netted intensively in an effort to track Indiana bats to roost trees. While efforts were unsuccessful in recapturing Indiana bats (John MacGregor, personal communication), the Service has been unable to obtain a report confirming negative data in follow-up surveys. At Picatinny Arsenal in New Jersey, a post-lactating female Indiana bat was captured during the first night of a survey for evidence of local reproduction. Efforts to catch reproductive females at Picatinny Arsenal in subsequent years were unsuccessful although male Indiana bats were captured (Annette Scherer, personal communication, Service). These occurrences in which maternity activity cannot be located despite confirmed or suspected presence of reproductive female Indiana bat(s) do not negate the apparent site fidelity of the Indiana bat in the use of maternity habitat. These cases may indicate the difficulty involved in capturing Indiana bats. The mist net guidelines indicate that there have been some situations when additional effort above and beyond the level of effort described in the guidelines was required to detect the presence of the species (Service 1999b). However in some cases listed above, follow up surveys were conducted in sufficient numbers to meet the mist net guidelines. In other cases, initial surveys did not gather information on the location of roost trees that would have assisted in relocating the colony.

Maternity Roosting Behavior

Roost Tree Selection

Indiana bats prefer forests with old growth characteristics, large trees, scattered canopy gaps, and open understory (Gardner et al. 1991b; Callahan et al. 1997; Forest Service 2000). Roost trees are larger in diameter than near-by apparently suitable trees (Kurta in press). Miller (1996) compared habitat variables for sites in northern Missouri where surveys for Indiana bats had been conducted and noted that significantly larger trees [>12 inches in diameter at breast height (dbh)] were found where reproductively active Indiana bats had been netted, than at sites where bats had not been captured. The average diameter of trees used by females is 36 percent greater that that of tree occupied by males (Kurta in press).

A variety of suitable roosts are needed within a colony's traditional summer range for the colony to continue to exist. One of the factors that influences the suitability of an area for habitat is the availability of individual roost trees within that area. Gardner et al. (1991), and Garner and Gardner (1992) suggested the optimal density of roost trees within an area is 6.9 potential roost trees per acre in uplands and 10.9 potential roost trees per acre in floodplains. Because they are frequently associated with dead or dying trees (Kurta in press), Indiana bat roosts are ephemeral. Roost longevity may vary due to factors such as the bark sloughing off or the tree falling down. Most roost trees may be habitable for only 2-8 years (depending on the species and condition of the roost tree) under natural conditions. Gardner et al. (1991b) evaluated 39 roost trees and found that 31 percent were no longer suitable the following summer, and 33 percent of those remaining were unavailable by the second summer. The presence of smaller live roost trees within a forested area is important to the long-term sustainability of the area as Indiana bat habitat.

Indiana bat colonies select roost trees based on structural characteristics, diameter of the tree, solar exposure and position in the canopy (Kurta et al. 2002; 3D/E 1995). Maternity roost trees in the core of the range as well as at the edge of the range apparently share these characteristics. Roost tree structure is probably more important than the tree species in determining whether a tree is a suitable roost site (Farmer et al. 1997). Maternity roosts are generally found in dead or dying trees with exfoliating bark, or live trees of species known for exfoliating or shaggy bark, such as hickories or white oaks. Occasionally, female Indiana bats may roost in crevices or tree cavities, but maternity colonies are rarely found in these situations (Menzel et al. 2001).

Most maternity roost trees generally receive a high amount of solar exposure, either as larger canopy trees or trees located near forest edges or openings with open canopy and an open understory (Callahan et al. 1997; Menzel et al. 2001). Solar exposure at northeastern maternity colonies may be a more important factor in roost tree selection than for colonies in the core of the range. In Vermont, Palm (2003) determined that maternity roost trees were more likely to be dominant in the canopy and farther from the nearest large canopy tree than randomly selected potential roost trees, and Kurta et al. (1996) documented roost trees in unshaded wetlands in Michigan.

Indiana bat maternity roosts can be described as "primary" or "alternate," based upon the proportion of bats in a colony occupying the roost site, and location in relation to forest canopy cover (Callahan et al. 1997; Kurta et al. 1996). Maternity colonies have at least one primary roost (up to five have been identified for a single colony in Vermont) used by the majority of the bats throughout the summer. Primary roosts must be able to provide a roosting site for many female Indiana bats with young. A colony’s alternate roost sites may be used less frequently, and by smaller numbers of bats.

Primary roosts are located in openings or at the edge of forest stands, while alternate roosts can be in the open or in the interior of forest stands. Thermoregulatory needs may be a factor in roost site selection. Primary roosts are generally in open canopy and can be warmed by solar radiation, thus providing a favorable microclimate for growth and development of young during normal weather. Alternate roosts tend to be more shaded, frequently are within forest stands, and are selected when temperatures are above normal or during periods of precipitation. Shagbark hickories seem to be particularly good alternate roosts because they provide cooler roost conditions during periods of high heat, and their tight bark shields bats from the encroachment of water into the roost during rain events (Callahan et al. 1997).

Most primary roosts are found in large, dead trees, generally ranging in size from 12.2 to 29.9 inches dbh (3D/E 1995). In Vermont, maternity roosts ranged from 19 inches to 36 inches dbh (Palm 2003, Britzke et al. 2004). Alternate roost trees also tend to be large, mature trees, but the range in size is somewhat wider than that of primary roosts (7.1 to 32.7 inches dbh) (3D/E 1995). The alternate roosts identified in the action area range from 5.3 inches dbh to 10.5 inches dbh (Apogee 2003). This is the smallest documented alternate roost tree utilized by a reproductively active female Indiana bat.

Bat Movements Among Maternity Roosts

Bats move among roosts within a season and when a particular roost becomes unavailable from one year to the next. Kurta et al. (1996) studied a maternity colony in northern Michigan over a three-year period, noting that roosting bats changed roost trees every 2.9 days, and that the number of roosts used by the colony ranged from **5** to 18. Other studies have shown that adults in maternity colonies may use as few as two, to as many as 33, alternate roosts (Humphrey et al. 1977; Gardner et al. 1991a; Garner and Gardner 1992; Callahan 1993; Kurta et al. 1993a; 3D/E 1995).

Humphrey et al. (1977) observed that each night after the sunset peak of foraging activity, the bats left the foraging areas without returning to the day roosts, which indicated the use of “night” roosts. When young are present, but not yet volant (capable of flight), the female bats will return occasionally throughout the night, presumably to care for the young.

Maternity colony movements among multiple roosts, particularly from primary roosts to alternate roosts, seem to depend on weather changes, particularly solar radiation (Humphrey et al. 1977) or periods of precipitation. Maternity movement between primary roosts from season to season is dependent upon roost availability. Kurta et al. (1993a) suggests movement between roosts may be the bats’ way of dealing with a roost sites as ephemeral as loose bark. The bat that is aware of alternate roost sites is more likely to survive the sudden, unpredictable destruction of its present roost than the bat which has never identified such an alternate (Kurta et al. 2002; Kurta and Murray 2002).

Due to the ephemeral nature of their roost trees, Indiana bats are not dependant on the continued suitability of a specific tree. As such, female Indiana bats have evolved to move over the landscape in response to the ephemeral nature of maternity roosts (i.e., large, dead trees). This coordinated relocation of a maternity colony is only known to occur in a slow, methodical manner, into familiar habitat (Kurta et al. 2002). In this Michigan study, the focal point of a colony’s maternity activity shifted 1.24 mile**s** over a three-year period after the primary roost tree fell down. The area that bats shifted to had been previously used by a single radio-tracked female for roosting during the summer prior to loss of the roost tree (Kurta et al. 2002). This is consistent with a number of other situations where the primary roost tree of a maternity colony had been lost and the bats moved to nearby roosts but retained the same commuting corridors and foraging areas (Humphrey 1977; Service 2002). Although Carter (2003) recognizes that female Indiana bats are faithful to a colony site, he suggests that, in the long term, Indiana bat maternity colonies must be "nomadic" because of their dependence on an ephemeral resource such as large, dead trees. Despite this theory, there is no evidence to suggest that bats are able to adapt to a sudden, abrupt loss of familiar gathering places and familiar roosting and foraging habitat. The availability and quality of adjacent habitat is important to the maintenance of a maternity colony (Service 2004c).

Maternity Foraging Behavior

After Indiana bats emerge from hibernation and migrate to their summer maternity areas, fat stores are expected to be extremely depleted. Fat stores in most bat species decline rapidly during hibernation (Fleming and Eby 2003). Migration subsequently can use between 10 and 25 percent of a bats' body weight in fat reserves (Fleming and Eby 2003). Upon arrival at summer maternity habitat, bats must restore their body weight and increase their food intake to prepare for giving birth. Reproductively active bats need to elevate biosynthesis in order to support pregnancy and lactation (Speakman and Thomas 2003). For example, basal metabolism of brown long-eared bats (*Plecotus auritus*) is nearly double for pregnant and lactating bats as compared to non-reproducing individuals (Speakman and Thomas 2003). However, the foraging efficiency of bats declines during pregnancy: a time when energy demands increase (Barclay and Harder 2003). Female little brown bats (*M. lucifugus*) spend 66 percent of their daily energy on foraging (Barclay and Harder 2003).

Streams, associated floodplain forests, and impounded bodies of water (e.g., ponds, wetlands, reservoirs) are preferred foraging habitats for pregnant and lactating Indiana bats, some of which may fly up to 1.5 miles from upland roosts (Gardner et al. 1991*b*). In riparian areas, Indiana bats primarily forage near riparian and floodplain trees (e.g., sycamore [*Platanus occidentalis*], cottonwoods [*Populus spp*.], black walnut [*Juglans nigra*], black willow [*Salix nigra*], and oaks [*Quercus spp*.]), and along forest edge on the floodplain (Belwood 1979; Cope et al. 1978; Humphrey et al. 1977; Clark et al. 1987; Gardner et al. 1991*b*). Within floodplain forests where Indiana bats forage, canopy closures range from 30 to 100 percent (Gardner et al. 1991b). Cope et al. (1978) characterized woody vegetation within a width of at least 30 yards of a stream as excellent foraging habitat. Indiana bats also forage within the canopy of upland forests, over clearings with early successional vegetation (*e.g*., old fields), along the borders of croplands, along wooded fencerows, and over farm ponds in pastures (Clark et al. 1987; Gardner et al. 1991b). Seidman and Zabel (2001) documented the use of intermittent and perennial streams by bats to forage. While this did not include Indiana bats, four of the seven species studied were of the genus myotis. Sparks et al. (in press) suggest that in heavily forested landscapes, the edges of open spaces may provide important foraging habitats.

In a recent study in the Allegheny Mountains (habitat similar to that of the Action Area), bat activity levels in non-riparian upland forest and forests in which timber harvest had occurred were low relative to forested riparian areas (Owen et al. 2004). Similar results have been reported in the Southeast (Menzel 1998), New England (Krusic et al. 1996; Zimmerman and Glanz 2000) and the Pacific Northwest (Grindal et al. 1999; Seidman and Zabel 2001). High levels of bat activity observed in riparian areas elsewhere often were related to the increased foraging efficiency associated with foraging in areas where insect abundances are greater (Barclay 1991; Grindal et al. 1999). Owen et al. (2004) speculates that the same is true in the Allegheny Mountains. The recent work of Owen et al. (2004) illustrates and further supports the biological importance of forested riparian habitats in the Appalachians. While this study was not specific to maternity activity, it stands to reason that riparian areas are all the more important for reproductive Indiana bats to increase foraging efficiency.

Maternity Colony Size
It is difficult to depict the size (population and geographic area) of a maternity colony, particularly if the Indiana bat maternity colony exhibits the fission-fusion society as described in the "Social Structure" section of this biological opinion. Nonetheless, the following sections summarize the best available scientific data with regard to the size of known maternity colonies.

Area
Indiana bats are known to occupy distinct home ranges during the summer (Garner and Gardner 1992) and return nightly to their foraging areas (Gardner et al. 1991b). Individual adult female Indiana bats in the same maternity colony show site fidelity to foraging areas throughout the summer and in subsequent years (Gardener et al. 1991b; Humphrey et al. 1997; Kurta and Murray 2002; Kurta et al. 1996 and 2002; Sparks el al. in press). While limited data imply that adults are solitary in their foraging activity (Kurta and Murray 2002; Murray and Kurta 2004), data on foraging bats has been limited to a small number of individuals relative the entire maternity colony.

Linear distances between roosts and foraging areas for females ranged from between 0.3 miles to 5.2 miles, although most distances were less then half that maximum distance (Murray and Kurta 2004; Sparks et al in press). For example, the maximum distance listed above was reported for one individual at a colony in Indiana. However, when 41 bats from this colony were tracked, the mean distance was 1.86 miles. Given the large and variable range of this species, it was not unexpected that there are large differences in home ranges. Murray and Kurta (2004) and Sparks et al (in press) speculated that the variations in distances to forage areas were due to differences in habitat type, interspecific competition, and landscape terrain. Therefore, studies from areas near the action area and in forested or mountainous habitats (Canoe Creek, PA) may be more representative of the bats' behavior in the action area. In Canoe Creek, Pennsylvania, an area with significant changes in elevation, reported distances between roosts and foraging areas ranged from 1.5 miles to 2.8 miles, with an average distance of 2.1 miles (Butchkoski and Hassinger 2002). During that study, no Indiana bats traveled over adjacent mountains (Brush and Lock Mountains). Seventy-eight percent of the area within the 2.8-mile radius was forested, with all bats foraging in the largest block of contiguous forest (3212 acres). Areas of more fragmented habitat were not used.

Roosts occupied by individuals ranged from 0.33 miles to more than 1.6 miles from preferred foraging habitat, but are generally within 1.2 miles of water (*e.g.*, stream, lake, pond, natural or man-made depression). In Illinois, the mean nightly foraging distance from a roost ranged from 0.34 mile**s** to 0.65 miles (Garner and Gardner 1992). Average foraging areas for individual Indiana bats varied from approximately 70 acres (juvenile males) to over 525 acres (post-lactating adult females)(Andy King, personal communication). The extent of foraging area used by an Indiana bat maternity colony has been reported to range from a linear strip of creek vegetation 0.5 miles in length (Belwood 1979; Cope et al. 1978; Humphrey et al. 1977), to a foraging area 0.75 miles in length, within which bats flew over the wooded river or around the riverside trees. The mean foraging area of three individual, reproductive female Indiana bats were 128 acres (pregnant), 232 acres (lactating), and 526 acres (post-lactating) (Garner and Gardner 1992). In Illinois foraging area for a lactating female was reported to be 850 acres, while a post-lactating female that had been subject to timbering activities used 625 acres (Gardner et al. 1991a, b).

Maternity colonies have often been found within forests that are streamside ecosystems or are otherwise within 0.6 miles of permanent streams. Garner and Gardner (1992) suggested that suitable Indiana bat roosting and foraging habitat be within 0.62 mile of water. Indiana bat roosts in Illinois were less than 0.68 miles from perennial streams (Gardner et al. 1991). Kurta et al. (2002) found that 38 roosts in Michigan were on average 0.409 $\pm$ 0.36 miles from lakes or ponds and 0.258 $\pm$ 0.45 miles from perennial streams. These water sources and associated forested riparian habitat, not only provide drinking water and food items, but also serve as flight corridors to suitable foraging habitat. A telemetry study in Illinois found most maternity roosts within 1640 feet of a perennial or intermittent stream (Hofmann 1996). Bats in Illinois selected roosts near intermittent streams and far from paved roads (Garner and Gardner 1992).

Foraging areas for six female Indiana bats in a Pennsylvania maternity colony were 96.4-276.8 acres in size (Butchkoski and Hassinger 2002). Core areas, where a bat spent 50 percent of its time while in main foraging areas**,** were located along intermittent streams or within hollows containing an intermittent stream. For the six female bats, only two core areas overlapped. Within the foraging areas ($\leq$ 2.8 miles) of radio-tagged bats in the Pennsylvania study, there were “large amounts of riparian and lakeside forests and especially forested mountainsides” (Butchkoski and Hassinger 2002). Indiana bats restricted foraging to within the largest island of upland forest (3038 acres) with slopes less than 10. Additionally, these foraging areas had a southerly aspect and were located along intermittent streams or within hollows containing an intermittent stream. This study was the first to occur in an area with significant changes in elevation, which is similar to the action area.

Sparks et al. (in press) suggest that the perfect foraging habitat for the Indiana bat would include forested streams interspersed with grasslands, croplands, or shrublands). 3D/E (1995) identified essential summer habitat as including at least 30 percent forested cover on a landscape scale. Farmer et al. (1997) indicated that optimal summer habitat has 20-60 percent forest cover, and that areas with less than 5 percent forest cover are not suitable for Indiana bats, while Garner and Gardner (1992) indicate that if over 11 percent of the area within 0.6 miles of a roost site is strip mine or barren land then the area should be considered unsuitable for the Indiana bat.

Population

A single Indiana bat maternity colony can vary greatly in size, and has usually been discovered with the capture of just one or two reproductively active female bats during the first year of survey efforts. The number of bats comprising a maternity colony is difficult to determine because colony members are dispersed among various roosts (Kurta in press). While most of the documented maternity colonies have contained 100 or fewer adult bats (Harvey 2002), as many as 384 bats have been reported emerging from one maternity roost tree in Indiana (Lori Pruitt, personal communication [c], Service). Recent counts at well-studied colonies (with at least three years of data) in Indiana and Vermont resulted in 104, and 200+ adult female individuals, respectively (Indianapolis Airport Authority 2003; Susi von Oettingen, personal communication). Based on twelve study results compiled by Kurta (in press), the mean maximum emergence count after young began to fly is 119 bats. This information suggests 60-70 adults in a primary roost at any one time (Kurta in press). Whitaker and Brack (2002) indicated that average maternity colony size in Indiana was approximately 80 adult bats.

There are limited data available that provide estimates of the size of maternity colonies in forested mountainous habitat similar to the action area. It must be noted that an exit count is the minimum number of individual Indiana bats that comprise a maternity colony. The following discussion is based on exit count data from a roost(s) because this represents the best available data. Gumbert (2001) observed 19 bats emerging from a roost in eastern Kentucky. Two years later, a colony of 34 bats was documented in another area of the same county (Apogee 2004a). Britzke et al. (2003) recently located three maternity colonies in the Nantahala National Forest in western North Carolina and Great Smoky Mountains National Park in Tennessee. The maximum numbers of bats exiting primary roosts were 28, 23 and 81 bats for the three different colonies. The maternity colonies discovered in the Britzke et al. (2003) study are at much higher elevations than that of the action area. Consequently, the climatic regime during the maternity season, especially mean minimum nighttime low temperature and maximum daytime high temperature, may be cooler than that of the action area. One of the confirmed maternity colonies in Kentucky is located in Hardin County on Fort Knox and consists of approximately 300 adult females (James Widlak, personal communication). The climate in this area is more similar to that of the action area. Based on these conflicting data, we are unable to make any conclusions regarding whether climatic or topographic factors within southern West Virginia are likely to result in maternity colonies that are consistently larger or smaller than the average colony size.

Summary

In summary, there are four apparent advantages to site fidelity and colonial roosting behavior: 1) maintains social interactions between members of the population (members of a colony have an established area to regroup each year to re-establish a maternity colony); 2) increases foraging efficiency (site familiarity enables individuals to reduce energy expenditure to forage); 3) decreases susceptibility to predators and other catastrophic events by being familiar with a multitude of roosting opportunities in a specific area; and 4) thermoregulation, as a result of colonial roosting, provides a physiological advantage to the raising of a pup.

These advantages increase the chance of survival for adults and young by allowing the adult to expend more energy for gestation, which in turn allows for more rapid development of fetuses, which increases the chance of an adult successfully bearing a pup. Once young are born, so long as the mother is nutritionally fit, she can expend more energy into lactation and development of young which improves the chance of: survival of young throughout the summer period and during migration back to the hibernaculum; young reaching puberty and breeding in their first fall and building appropriate fat reserves to survive hibernation. In addition, increased foraging efficiency improves the fitness of the adult at the end of the maternity period, which in turn, improves the chance of: survival of the adult during summer and migration back to the hibernaculum; breeding during the fall; and building appropriate fat reserves to survive hibernation. Once site familiarity is altered, it is not known how individuals of a maternity colony, let alone the entire colony would react.

Although female Indiana bats have evolved to move over the landscape in response to the ephemeral nature of maternity roosts (i.e. large, dead trees), the coordinated relocation of a maternity colony is only known to occur in a slow, methodical manner, into familiar habitat (Kurta et al. 2002). While Carter (2003) recognizes that female Indiana bats are faithful to a colony site, he suggests that, in the long term, Indiana bat maternity colonies must be "nomadic" because of their dependence on an ephemeral resource such as large, dead trees. Despite this theory, there is no evidence to suggest that bats are able to adapt to a sudden, abrupt, or large scale loss of familiar gathering places and familiar roosts and habitat.

Although maternity colonies continue to exist in highly fragmented habitats, it is not known whether this suggests adaptability, or conversely, the inability to move large distances over relatively short time periods while maintaining cohesiveness of the maternity colony. Given the dramatic and indeterminate population declines of the species, there is little support that the Indiana bat is highly adaptable to large landscape level changes to their maternity habitat. Murray and Kurta (2004) observed that Indiana bats in a maternity colony never crossed open areas (open wetland or agricultural fields), and followed treelines or fencerows to reach foraging areas, even though it required more energy and increased commuting distance by 55 percent. It is apparent that a variety of suitable roosts within a colony's occupied summer range should be available to assure the persistence of the colony in that area (Kurta et al. 1993a, Callahan et al. 1997).

Limited evidence suggests that the Indiana bat may tolerate some degree of habitat disturbance. In northern Missouri, maternity roosts were found in areas that were near disturbances such as residences or cattle pastures (Callahan 1993; Miller 1996). Selective timber harvest activities neither directly damaged known roosts nor discouraged bats from continuing to forage in an area that had been harvested in Illinois (Gardner et al. 1991a) so long as the currently used roosts were not removed and foraging habitat remained intact. However, there were no data collected to evaluate reproductive success before or after disturbance and given the philopatric nature of this species, the continuing return of the Indiana bat to an area does not translate to a viable maternity colony where recruitment exceeds mortality.

If the summer range is modified such that females are required to search for new roosting habitat or foraging areas, it is assumed that this effort places additional stress on pregnant females at a time when fat reserves are low or depleted and they are already stressed from the energy demands of migration (Kurta et al. 2002, Kurta and Murray 2002). This, in turn, could affect the reproductive fitness and productivity of the bats. It is not known what degree of disturbance female Indiana bats can tolerate and continue to maintain a viable maternity colony. As mentioned previously, a possible cause for the declining trend of this species is that habitat alterations are causing reduced numbers of bats within maternity colonies, and in some cases these maternity colonies may be extirpated, prior to their discovery (Service 1983; Kurta and Murray 2002; Kurta et al. 2002; McCracken 1988; Racey and Entwistle 2003).

Fall Swarming

Upon arrival at hibernation caves in August through September, Indiana bats "swarm," a behavior in which "large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day" (Cope and Humphrey 1977). Very little is known about behavior and habitat use by Indiana bats during the fall swarming period, and what little is known is based primarily on males.

Swarming continues for several weeks (August through October) and mating occurs during the latter part of the period. Fat supplies are replenished as the bats forage prior to hibernation. Indiana bats tend to hibernate in the same cave in which they swarm (LaVal et al. 1976), although swarming has occurred in caves other than those in which the bats hibernated (Cope and Humphrey 1977). Male Indiana bats may make several stops at multiple caves during the fall swarming period. During swarming, males remain active over a longer period of time at cave entrances than do females (LaVal and LaVal 1980), probably to mate with the females as they arrive. The time of highest swarming activity in Indiana and Kentucky has been documented as early September (Cope et al. 1977). After mating, females enter directly into hibernation. Swarming activity in West Virginia has been documented in early October with little activity after the middle of October. No Indiana bat activity was detected after November 15 (Mark Ford, personal communication).

During the fall, when Indiana bats swarm and mate at their hibernacula, male bats roost in trees nearby during the day and fly to the cave during the night. In Kentucky, Kiser and Elliott (1996) found male Indiana bats roosting primarily in dead trees on upper slopes and ridgetops within 1.5 miles of their hibernaculum. During September in West Virginia, male Indiana bats roosted within 3.5 miles in trees near ridgetops, and often switched roost trees from day to day (Ford, et al. 2002). Fall roost trees tend to be exposed to sunshine rather than shaded (Menzel et al. 2001).

Indiana Bat Status Summary

Historic Conditions

Prior to European settlement, deciduous hardwood forest was the dominant land cover in the Eastern and Midwestern United States, and "...millions of now endangered Indiana and gray bats lived in single caves, and their overall abundance likely rivaled that of the now extinct passenger pigeon" (Tuttle et al. 2004). For example, conservative estimates suggest that as many as 9 to 13 million Indiana and/or gray bats hibernated in one hibernaculum (Mammoth Cave System) historically (Tuttle 1997). An Indiana bat colony in Bat Cave, Edmonson County, Kentucky, was catastrophically eliminated by a flood event in the mid-1900's. Analysis of bone deposits revealed remains of an estimated 300,000 individual Indiana bats (Hall 1962).

Throughout the range of Indiana bats, a substantial amount of the forested habitats that would have provided foraging habitat and maternity sites for these bats has been destroyed over the past 300 years. The region that includes the Action Area, lost about 60 percent of its forested habitat since pre-Colonial times (Powell and Rappole 1986, see "Table 11"). Although the amount of forest cover in the eastern United States stabilized from 1987 to 2002, and overall has increased since the low point of 1945, lowland hardwoods in the east experienced their greatest declines between 1963 and 2002, losing about 15 million acres of cover over this 39-year period (Heinz Center 2002).

Table 11. Forest area in the United States by Region, from Pre-Colonial Times to 1977 (in thousands of acres). Adapted from Powell and Rappole 1986.

Region	Pre-Colonial	1872	1920	1945	1963	1977	% Remaining
Central	421,500	200,100	148,710	171,170	173,150	167,290	40
Mid Atlantic	172,000	60,310	70,865	84,658	86,924	96,413	56
South	738,000	503,080	439,510	431,520	510,020	478,680	65

Central Region includes Ohio, Indiana, Illinois, West Virginia, Kentucky, Tennessee, Iowa, Missouri, eastern Kansas, and eastern Nebraska; Mid Atlantic Region includes New York, New Jersey, Pennsylvania, Delaware, and Maryland; South Region includes Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, eastern Texas, and eastern Oklahoma.

In addition, the states within the historic distribution of Indiana bats have also lost substantial portions of their wetlands, including forested wetlands, since pre-Colonial times (Dahl 1990). West Virginia lost about 24 percent of its wetlands between the 1780s and 1980s; Ohio lost about 90 percent of its wetlands; Virginia lost about 42 percent; Kentucky lost about 81 percent; and Illinois lost about 85 percent (Dahl 1990).

While we do not know precisely how many Indiana bats existed during the pre-colonial period, limited information, as described above, suggests that Indiana bats were numerous. However, we do not have information on the population sizes and trends of Indiana bats that would allow us to correlate changes in the total abundance of the bats, generally, or the abundance at particular hibernacula, with changes in forest cover throughout the bats' range. We also do not know whether or to what degree Indiana bats have been affected by changes in forest cover throughout their range.

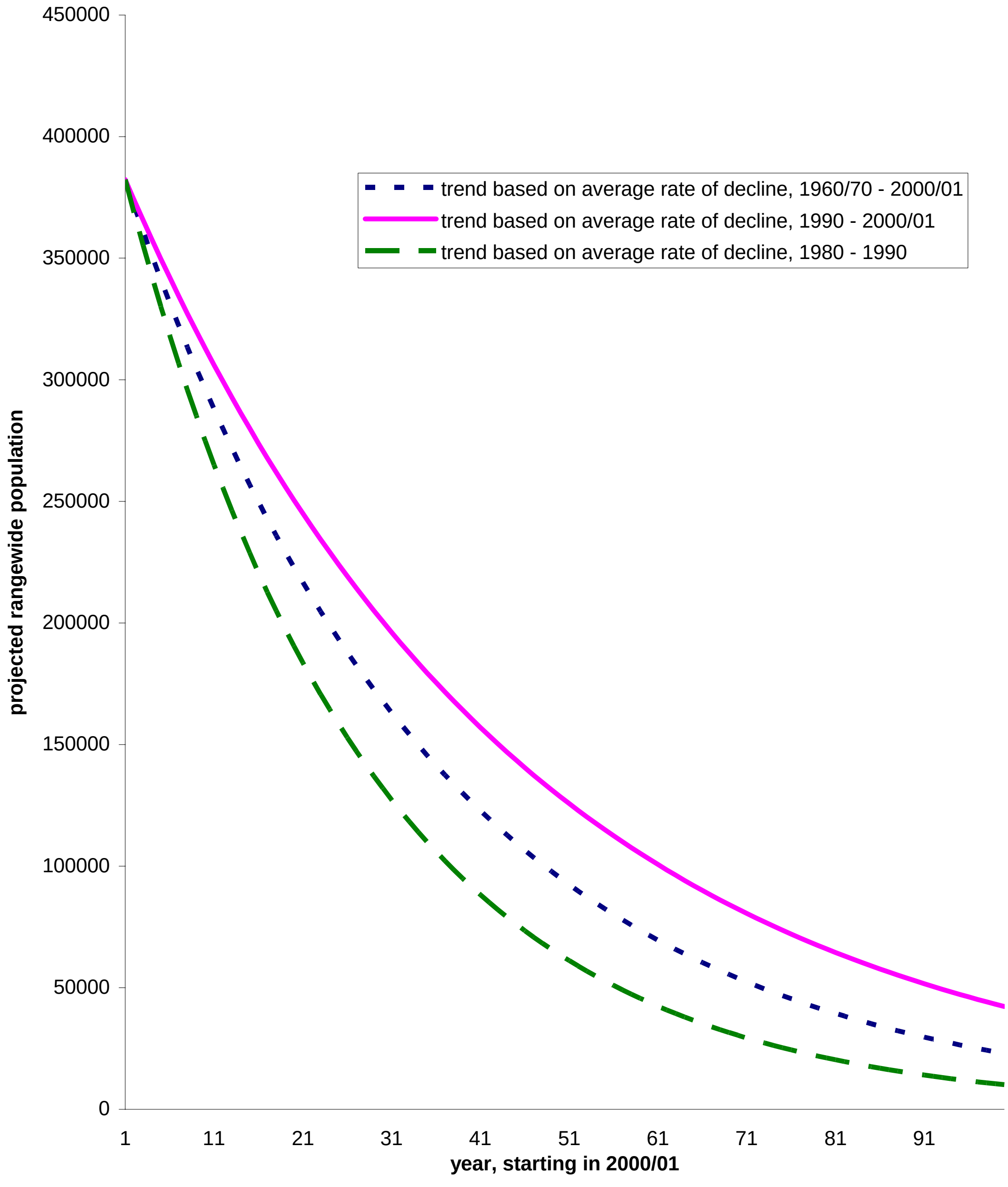
Current Conditions

Bats comprise one-fifth of all mammal species and only rodents are more numerous (Harvey et al. 1999). Several North American bat species, including the little brown bat, Northern long-eared bat, (*M. septentrionalis)*, Eastern pipistrelle, (*Pipistrellus subflavus)*, and Brazilian (Mexican) free-tailed bat, (*Tadarida brasiliensis)*, have large geographic ranges and number in the tens or hundreds of millions. Additionally, bats are the most gregarious of all mammals (Hill and Smith 1986). For example, an estimated 100 million Mexican free-tailed bats summer in central Texas, and this is a fraction of the species range (Bat Conservation International 2004). While the Indiana bat continues to have a large geographic range (27 states, also see Figure 2), the range-wide population of the Indiana bat has declined 56 percent from approximately 883,300 Indiana bats in 1960/1970 to 387,301 in 2003/2004 (Clawson 2002; Lori Pruitt, personal communication [a]). Although the most recent census (2003/04) shows a one percent population increase from the last monitoring period (2001) (382,299 to 387,301), quality control has not been completed for this data set and therefore, it is considered preliminary (Lori Pruitt, personal communication [a]). Population fluctuations from year to year can be attributed to such factors as weather affecting the success of reproduction for a given year (Humphrey et al. 1977; Ransome 1990). Regardless, this one datum point does not reverse the long-term downward trend. During the last 30-40 years, the population trend of the Indiana bat has steadily declined (Tables 4 and 6).

Outlook

In an effort to provide context for evaluating the effects of actions that impact the Indiana bat, we have graphed simple deterministic100-year population projections based on historic population trends since approximately the 1960s. (Diagram 1). This allows us to visualize future population growth/decline if previous trends continue. As discussed in the “Range-wide Hibernacula Censuses” section, care must be taken when extrapolating survival rates from short-term or individual studies as age structure and survival rates can vary greatly among hibernacula and maternity colonies and from year to year (Ransome 1990; Humphrey and Cope 1977). Therefore, trends over a decade, rather than between individual survey years were used.

Diagram 1. Projected Population Trends Based on Observed Rates of Decline.



Projections based on the 30-year average decline (~1970-2000) of the Indiana bat result in a population declining by approximately 50 percent every 22 years. Although this may slightly overestimate the rate of decline if some of the baseline numbers were obtained in the 1960s[6], projections based on the trend observed during the decade of steepest decline (1980s) indicate that the population may be halved in as little as 16 years. The most optimistic projection, based on rate of decline documented in the 1990s**,** provides an estimate of 28 years for the population to decline by another 50 percent from current numbers.

There are several reasons why the outlook for the Indiana bat may be even more precarious than suggested by the projection in Diagram 1:

1. Indiana bats exhibit colonial behaviors in virtually every stage of their life history. Such colonial traits may substantially affect both survival and productivity. Unfortunately, accelerating declines in survival or productivity due to collapse of these types of interactions are usually impossible to detect until after the fact. While there is no way to prospectively determine the risk of crossing a threshold, beyond which population declines may be subject to rapid acceleration that are increasingly difficult to reverse, this risk must be considered, especially for such a social species (Racey and Entwistle 2003; Callahan 1993; Gardner et al. 1991b).

2. The Indiana bats has a low reproductive rate and slow population growth which inhibits the opportunity to recover from population declines (Racey and Entwistle 2003). Bats are the slowest reproducing mammals on earth for their size with most producing only one young per year.

3. The declining trend in Indiana bat numbers is both long-standing and widespread. A sustained 30+ year decline over four states that once supported more than three-quarters of the entire population cannot be attributed to short-term reversible perturbations in species abundance or to local environmental conditions.

These issues are particularly important given the fact that basic bat population dynamics indicate that as this species' numbers decline, this downward trend will at some point, preclude the opportunity of both survival and recovery in the wild.

Conservation Needs of the Indiana Bat

Species With Similar Life History Strategies

Indiana bats are not unique in having wintering areas that are spatially separated from summer, breeding habitats. Humpback (*Megaptera novaeangliae)*, and northern right whales (*Eubalaena glacialis)*, migrate between northern feeding areas and tropical rearing areas. In the Atlantic Ocean, loggerhead sea turtles (*Caretta caretta)*, will migrate from the coast of Florida to the

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[6] The projection assumed that the rate of change was based on a ten year interval between 1960/70 and the 1980 estimates; and 30 years between the 1960/70 and 2000/01. If some counts were actually made in the 1960s, then the annual declines should have been averaged over 10-20 and 30-40 years, respectively.

Mediterranean Sea and back to complete their life cycles. In the Pacific Ocean, Pacific salmon, (*Oncorhynchus* species), migrate between freshwater spawning habitat and marine rearing habitat to complete their life cycle. Monarch butterflies (*Danaus plexippus)*, migrate between wintering habitat in Mexico and rearing habitats in temperate North America. Whooping cranes, *Grus Americana*, migrate between wintering habitat along coastal Texas and nesting habitat in northern Alberta and Northwest Territories in Canada. Most North American songbirds (including endangered species like golden-cheeked and Kirtland's warblers) and many species of shorebirds, waterfowl and raptors migrate from wintering areas in Mexico, the Caribbean, Central America and South America to reproduce in temperate North America.

With all of these species, scientists have debated the relative importance of the different habitats for the conservation of these species (for examples, see "Hagan III and Johnston 1992", "National Research Council 1996", "Rappole 1995", "Terborgh 1989"). When puddle ducks and diving ducks declined by about 40 percent in Chesapeake Bay between the 1950s and 1980s, many investigators blamed the declining condition of the bay, which supports wintering populations of these species, others blamed the loss of the wetlands in the Prairie Pothole region in which large numbers of these species breed, while others recognized that losses in both areas contributed to the decline (Terborgh 1989). Similar debates have surrounded the decline of sea turtles in the Atlantic and Pacific Oceans, whales, Pacific salmon, shorebirds, raptors, and songbirds (Askins et al. 1990, Bohning-Gaese et al. 1992, Finch 1990, Hagan III and Johnston 1992, Myers et al. 1987, Rappole 1995, Robbins et al. 1989).

The Service has consistently recognized the necessity of protecting species throughout their entire life cycle rather than focusing all conservation efforts in one habitat for a particular life stage, over all others. For almost three decades the Service has argued that, to conserve the wild population of whooping cranes, it is necessary to protect habitat along the Platte River where the cranes stop during their migration. Similarly, the Service has several programs in place — Western Hemisphere Convention, Partners in Flight, and the Tripartite Agreement with Canada and Mexico — that are designed to protect migratory species throughout their life cycles: wintering habitat, migratory habitat, and summer habitat.

At least two fundamental principles underlie this strategy. First, declines due to impaired survival and/or reproduction at one stage in the life cycle do not preclude concurrent irreversible loss of habitat functionality at other life stages that may ultimately become the major determinant of a species survival and recovery. More immediately, however, a species that is experiencing a serious decline is placed at further risk by losses at any other stage in the life cycle. Indeed, a serious on-going population decline requires immediate implementation of available measures to increase survival and reproduction at all stages in the life cycle or, at the very least, to avoid compounding the downward trend.

Indiana bat

The annual cycle (for females) of hibernation, spring migration, parturition, lactation, fall migration, mating, and hibernation can be broken at any point, resulting in the loss of that individual from the population, and her remaining reproductive potential in the population. The vulnerable point(s) in this cycle may very well differ by geographic area, and even within the same area. Ransome (1990) further identifies the limiting factors that control the overall bat population as the number of maternity colonies and the proximity and quality of foraging areas surrounding each maternity site. He also concludes that a reduction in the number of maternity colonies contributing to a hibernaculum is a prime factor that should be considered when evaluating the causes of population declines in bats. Unless a change in these environments occurs to allow recruitment to exceed mortality, the species will continue to decline.

Many authors have established that protecting the Indiana bats' winter hibernacula is necessary to prevent further declines of this species and that the quality of these habitats can be limiting for the bats (for example, see "Service 2004c"; "Service 1983"; "Service 1999b"). This is widely accepted largely because the declines can be readily observed through hibernacula censuses. The response of Indiana bat populations to changes in the availability of habitat that supports maternity colonies and roost sites is not as clear (for example, see Service 2004c; Service 1983; Service 1999b), particularly because Indiana bats in maternity habitat are widely dispersed, difficult to track, and demographic data is not readily collected. Despite this uncertainty, any impairment of survival or reproduction will compound losses at the hibernacula. Further, Racey and Entwistle (2003) suggest that an effective conservation management unit for temperate bats should be at the maternity colony level. Indiana bats show fidelity to maternity colony areas, but there are questions about whether this habitat might be limiting to Indiana bat populations and/or whether disrupting these colonies comes at some cost to reproduction and/or survival. Despite this uncertainty, protection of only one life stage (hibernacula) is not adequate to ensure the survival and recovery of this species. All other life stages, particularly the birthing and raising of young**,** must be managed or protected as well to allow for adequate recruitment. Given the magnitude of the destruction of forest cover throughout the historic range of Indiana bats, if we assume that the availability of the habitat necessary to support maternity colonies for these bats has had (and will continue to exert) no effect on the Indiana bats' population trend (or the trend of some of the hibernacula, if not all of them) and this assumption later proves false, we will have failed to protect Indiana bats when protection was warranted and necessary to prevent further declines. Worse, we will have precluded the species' chances of recovering from endangerment.

Based on experiences with species of similar life history strategies as the Indiana bat, this Opinion assumes that preventing Indiana bats from becoming extinct will require efforts that conserve the habitats that support the three major stages of the bats' life cycle: winter hibernacula, maternity habitat, and the migratory habitats that connect the two. Adequate summer maternity habitat (roosts with appropriate microclimatic conditions for raising young, adequate foraging area, etc.) is crucial to ensure successful recruitment and reduce the mortality rate. Given the colonial nature and site fidelity of this species, the capability for a female Indiana bat to only give birth to one pup annually, and considering that maternity colonies and hibernacula form an interdependent meta-population, it is imperative that all known maternity colonies be adequately protected or managed to ensure their contribution to the population.

Summary

The debate over the relative importance of habitats that support one portion of the Indiana bat's life history (winter hibernacula) over another portion (summer maternity) of their life history is similar to that of the aforementioned species with similar life history strategies (Service 2004c). The reality is that Indiana bats evolved a life history strategy that leads them to migrate from hibernacula to summer foraging habitat where they gain the energy they need to reproduce, rear their young, and survive the winter. As a result of natural selection, only phases of life history strategies which improve the species' chances of survival are developed (Stearns 1992). To successfully complete its life cycle, each bat needs to complete each stage of this life history strategy. The probability of successfully completing this life cycle is the combined probability of completing each component of the cycle; if an individual bat has a low probability of success in one phase of its life cycle, it has a low probability of successfully completing the entire, annual cycle (Myers et al. 1987).

In order for the Indiana bat to have a reasonable chance for survival and recovery, the current population must be initially stabilized and then increased. The only options available for stabilizing and increasing the population are to increase its recruitment (birth and survival of young to breeding age) or reduce its mortality rate. The resilience of Indiana bats to adverse environmental conditions is severely limited by the species' relatively low reproductive capability (Humphrey et al. 1977; Racey 1982; Barclay and Harder 2003; Racey and Entwistle 2003). Some species that experience declines during unfavorable periods are capable of quickly responding to improvements with rapid population growth. However, the Indiana bat cannot. Even if survival at each life stage increases dramatically, the Indiana bat population growth will be constrained by a maximum fecundity of one pup per female per year (Humphrey et al. 1977; Racey 1982; Barclay and Harder 2003; Racey and Entwistle 2003). Thus, depleted populations are likely to remain vulnerable for long periods of time.

ENVIRONMENTAL BASELINE

As described above, the action area is located in the Sherman District of Boone County, West Virginia, between Peytona and Williams Mountain. This area is within the Allegheny Plateau Physiographic Region of West Virginia, which is characterized by narrow, winding ridges and hollows covered with mixed mesophytic forests. The elevation range of the action area is approximately 900 feet to 1900 feet. There are approximately 5850 acres and 25 miles of streams within the action area. Streams present within the action area two larger perennial streams, Sandlick Creek and Laurel Creek, as well as include numerous intermittent streams that are tributaries to either Sandlick or Laurel Creeks. Additional unquantifiable lengths of streams subject to downstream water quality effects are also included in the action area.

Indiana Bat Survey Efforts

Indiana bats are difficult to survey. Mist net guidelines (Service 1999b) were designed to establish the minimum effort required to detect the presence of Indiana bats (Garner and Gardner 1992; Gardner et al.1996)**.** The Service mist-net guidelines and other sources state that multiple captures of Indiana bats (adult females or young of the year) between May 15 and August 15 indicate that a maternity colony is active in the area. Most maternity colonies have been discovered through the capture of only one or two reproductively active female bats during mist net studies.

2003 Survey Efforts

The following data from 2003 was provided to the Service in the biological assessment. To determine if Indiana bats were present, mist-net surveys were conducted on four proposed mine sites between July 14 and August 4, 2003. These mine sites are all clustered closely together within the Laurel Creek and Sandlick Creek drainages. The survey protocols followed the mist net survey guidelines as found in the Draft Indiana Bat Recovery Plan (Service 1999b). A total of 36 sites were surveyed for a total of 144 net nights of effort. All survey sites were located within the associated permit boundaries, and were within approximately 3 miles of the center point between the Laxare and Black Castle Contour mines. A total of 311 bats of 8 species were captured during these survey efforts. A summary of the survey data is provided in Table 12. The big brown bat (*Eptesicus fuscus*) was the most common species captured, followed by the Eastern red bat (*Lasiurus boreali*) and the Eastern pipistrelle (*Pipistrellus subflavus*). Of the four mine areas, the Laxare East project had the highest overall catch per unit effort for bats, followed by the Black Castle Contour site. These are the two projects where Indiana bats were captured.

Table 12. Mist net and portal survey data.

Mine	# of net sites	Date of survey	Indiana bats captured	Open portals	Total # species	Total # bats
W. Stollings	9	July 23-27	0	0	4	54
Lexerd	7	July 31-Aug 4	0	0	6	28
Black Castle *	8	July 14-22	1 (7/23)	0	7	57
Laxare East	12	July 26-Aug 2	1 (7/29)	0	7	172

* Survey included sites for Short Ridge and Checkmate amendment

A post-lactating Indiana bat (# 3351) was captured on July 23rd, 2003, on an upland road corridor within the area of proposed valley fill 11 of the Black Castle Contour permit area. The net site was on a south-facing slope in the headwaters of Sandlick Creek. The bat was fitted with a radio-transmitter and was tracked for 11 days. Two roost trees were located on the site of the proposed valley fill C of the Laxare East permit area, near an unnamed tributary of Sandlick Creek, approximately 2,500 feet from the capture site (Figure 5). The trees were within 75 yards of each other. Both of these trees were dead basswood (*Tilia americana*) which apparently had been damaged during logging activity that started in this area in late March of 2002. The tops had been snapped off and very little to no bark remained on either tree. One tree was 20 feet high with a 10.55 inch dbh, and the other tree was approximately 12 feet high with a 7.28 inch dbh. Very limited data concerning emergence counts were obtained, however one emergence count was conducted on both trees on August 5. Two bats were seen exiting one tree and three bats were seen foraging in the shelterwood cut area near the roost trees. No bats were seen exiting the other roost tree.

Another post-lactating Indiana bat (# 3352) was captured on July 29, 2003, near the mouth of Orchard Branch of Sandlick Creek on a small, unimproved road corridor on the Laxare East mine site (Figure 5). The capture site is located immediately downstream of the proposed valley fill G in Orchard Branch and within the proposed pond G2. This capture site is 1.22 miles from the other capture site. This survey site yielded 64 individual bats of six species, the highest number of bats captured per site during the entire survey effort. Off-road vehicle traffic prematurely closed down the survey on the second night. The adjacent net site, 1,500 feet upstream in Sandlick Creek, was also disrupted on the same night as the capture of bat # 3352, and was closed after 0.5 hour of survey effort.

A radio-transmitter was attached to bat # 3352, and roost tree and foraging data were collected for nine days. Three roost trees used by this bat were located within 100 yards of each other on the Laxare East mine site, immediately adjacent to a tributary of Snadlick Creek that is proposed to be filled as part of valley fill G (Figure 5). Roost trees include a dead red oak (*Quercus rubra)* (453) with a dbh of 5.35 inches; a dead scarlet oak (*Q. coccinea)* (454) with a dbh of 5.31 inches; and a dead scarlet oak (untagged) with a dbh of 6.10 inches. These trees had bark that was moderate to high in suitability for use by Indiana bats. The roost trees for bat # 3352 were approximately 1,700 feet from the capture site. No emergence counts were conducted for this bat and its associated roost trees. The bat was radio-tracked on the night of August 5 while foraging. The bat traveled along Orchard Branch down to Sandlick Creek, where the signal was lost.

Indiana bat roost trees were located at elevations of 1,270 to 1,460 feet, on steep (30.6 – 50.9 degree) slopes in the action area. The two roost trees of bat # 3351 are on a slope with a northwestern aspect, and the three roost trees of the bat # 3352 are on a southwestern aspect. Average distance from the five roost trees to first-order streams is 609.9 feet and 1.09 miles from a second-order stream (Sandlick Creek). Although bat # 3352 used roost trees with suitable bark, the trees were even smaller in size than those used by bat # 3351. The roost trees for bat # 3352 were sub-canopy trees located in dense forest with a southwestern aspect, but according to the BA, were protected from direct sunlight.

2004 Survey Efforts
Additional mist net surveys within the action area were conducted between July 8 and July 23, 2004 (Apogee 2004b). While the scope and design of these studies were not coordinated with the Service, the Service’s mist net guidelines were followed. There were 72 net nights of effort at 18 mist net sites concentrated in the Sandlick Creek watershed. These studies confirmed the continued presence of Indiana bat maternity activity within the action area. On July 11, 2004 a lactating female Indiana bat was captured in the headwaters on Sandlick Creek. No band was located on this bat at the time of capture, so it is likely a different female than the ones captured in 2003. Over the course of 11 days, this bat (banded A09083) was tracked to three roost trees within the site of proposed valley fill C of the Laxare East permit, near an unnamed tributary of Sandlick Creek (Figure 5). This is the same roost area as was used by bat #3351 from 2003. This area is referred to as the “western roost area”, and will be discussed in more detail below. This bat used one of the same roost trees as were used in 2003, plus two new roosts. The new roost trees identified were both either dead or damaged sugar maples. Emergence counts documented up to four bats leaving a tree at one time, however from the data provided it appears that emergence counts were only conducted on trees used by the bat captured this season, and no counts were conducted on trees located along Orchard Branch (previously used by bat #3352), or on trees 453 or 454 (previously used by bat #3351). Foraging data was gathered each night the bat had a transmitter attached. The bat appears to be using the valley near the roost trees (the site of Laxare East’s proposed valley fill C) and the headwaters of Sandlick Creek near the site of

Black Castle Contours proposed valley fill 11 as foraging areas. There was no documented Indiana bat activity in the vicinity of the “eastern roost area.” Conclusions based on these survey efforts will be described in the “Environmental Baseline – Maternity Colony Size” Section below.

Factors Affecting the Indiana Bat Habitat within the Action Area

As described below, the action area and adjacent areas have been subject to previous mining and recent logging activities, which may have already had adverse affects on the Indiana bats present within the action area. The effects of the proposed projects add to the effects already present in this baseline condition.

Logging in the Action Area

Approximately 800 acres of the action area was logged between March 29, 2002, and August 8, 2003. Approximately 90 percent of the Orchard Branch watershed and the headwaters of Sandlick Creek were logged starting in March 2002, with only the portion of Orchard Branch containing roost trees for bat #3352 remaining un-timbered. The most recent logging in the area around the roost trees was done approximately 10 years ago (Richard Dearing, personal communication). Selective harvest was conducted from the lower slopes to the ridgeline of the Laxare East permit area. From July 2002 until mid-November 2002, logging was completed in the headwaters of Sandlick Creek between the left and right forks where bat # 3351 was captured. The Morgan Branch watershed was also logged six years ago, again two years ago, and in the summer of 2003. During this time period, trees were also selectively cut on the Black Castle Contour area between Sandlick Creek and Laurel Creek. All of this area was considered by the logging company to be 10 years short of their optimum cutting time, but was cut at this time due to the proposed mining (Richard Dearing, personal communication). The logging company cut trees of a smaller diameter (down to12 inch dbh or 16-inch stumps) in the proposed valley fills areas. Trees were also selectively cut on the lower slopes, in areas that will not be directly affected by mining.

According to the forester for the logging company, cull trees remain on the Laxare East mine site and in the headwaters of Sandlick Creek. These are defined as trees with diameters from 24 to 36 inches that are hollow and considered unusable for lumber. Generally, they are scarlet and chestnut oak on the ridges and beech (*Fagus grandifolia*) in the lower elevations. These trees could be used as roost trees by Indiana bats. According to the BA, the Laxare East site has an open canopy with white oak, mockernut hickory, black oak (*Q. velutina)*, pignut hickory, yellow poplar, sugar maple, and black locust.

Even though it has been recently selectively logged, the proposed 664.86-acre Black Castle Contour mine site is primarily forested. According to the BA, the trees surrounding each roost tree were examined in 0.24 acre circular plots. It was determined that 70.7 percent were oak species, 26.8 percent were other hardwoods, and 2.4 percent were conifers. Out of 41 trees measured during this survey, 22 percent were dead and exhibited varying degrees of usable bark. Twenty percent of all trees in the survey had bark that is considered usable for Indiana bat roosting.

There is little quantitative information on the effect of timber management practices on Indiana bat maternity colonies, however anecdotal evidence suggests that Indiana bats may be tolerant of timber harvest methods that retain snags and large trees (Menzel et al. 2001). In Illinois, Indiana bats continued to use established roost trees that were located in an area that had been selectively cut (Gardner et al 1991b). Callahan (1993) found Indiana bat maternity roosts in areas that had been logged in the past 20 years, and noted that those habitat modifications may have benefited the bats by removing some of the canopy cover and leaving standing dead trees. Opening of the canopy cover could affect thermal properties of the roost site. Increased solar exposure, within the tolerance limits of the bats, could benefit reproduction by accelerating fetal development (Gardner et al 1991b).

This information indicates that even though the action area has been selectively logged, it continues to provide dead or live trees suitable for Indiana roost trees. Continued Indiana bat use has been documented in the area. Based on the documentation of Indiana bat use, the area should still be considered suitable habitat for the Indiana bat. Because timber harvest occurred during the summers of 2002 and 2003 within the summer range of Indiana bat maternity sites, some unknown number of bats may have been directly killed or harmed as trees were felled. In 2003, the two female bats could have been displaced from the maternity roost trees due to the logging activity or they may have completed the rearing of their young and were using alternate roost trees.

Terrestrial Impacts from Previous Mining

Approximately 25 percent of the action area (1,462 acres) has been or is currently being mined (Table 13). Five active or recently (with the last 20 years) reclaimed mines located adjacent to the proposed Black Castle Contour make up the majority of this area. These previously mined areas no longer provide suitable roosting or foraging habitat for Indiana bats as they are currently non-forested grassland or bare land. Strip mined areas are generally classified as unsuitable for Indiana bats (Garner and Gardner 1992), and foraging studies have found that Indiana bats selectively avoid using grassland type areas (Gardner et al 1991a). Further, as part of a project review of a proposal to construct a powerline corridor, mist net surveys were conducted in June 2004 within reclaimed areas of the White Castle mine (Permit S-5075-86). In evaluating the suitability of this area for Indiana bats, Apogee described this habitat as "very poor" and noted that the reclaimed mine areas lacked suitable trees or corridors that would provide Indiana bat habitat (Apogee 2004c). The mist net survey confirmed that few bats used these areas. During a total of eight net nights of effort only one individual, a northern bat (*M. septentrionalis*) was captured (Apogee 2004c). As a result of this review, the Service determined that reclaimed minelands within the action area do not provide suitable Indiana bat habitat.

The mining in and around the action area has fragmented much of the remaining forested habitat. For example, there is an approximately 100-foot wide area above the proposed Black Castle Contour area that is currently forested. However, this area is surrounded by mine lands, and no forested travel corridors are available to connect these areas to streams, riparian areas, or other large blocks of forested habitat. These areas are therefore also not expected to provide suitable Indiana bat habitat.

Table 13. Completed and active mining within the Action Area

Mine Name and SMA #	Acres	Current habitat
White Castle S-5075-86 (reclaimed)	410	grassland & coal stock pile
Black Castle #2 S-6026-88 (active)	350	grassland & bare ground
Black Castle S-6014-87 (reclaimed)	245	grassland
Checkmate S-6006-87 (active)	61	½ grassland, ½ bare ground
Black Castle #3 S-6011-89 (reclaimed)	235	Grassland
Black Bishop deep mine U-5005-94 (active)	<10	bare ground
Black King deep mine U-5006-94 (active)	<10	bare ground
Buffalo Creek S-5006-96 (overlaps E. of Stollings)	NA	grassland or bare ground
Jacks Branch S-0079-84 (overlaps Laxare) (reclaimed)	131	grassland with planted pine trees ~ 15' high
Deep mine U-0030-85 (reclaimed)	<10	grassland with planted pine trees
Total acres disturbed by mining	1462	

One large, ongoing mining permit is located immediately adjacent to, but outside of the action area. The East of Stollings permit is an approximately 1,238 acre mountaintop removal operation located on the western border of the action area between Mudlick Fork and Stollings Fork, both tributaries of Laurel Creek. Mining at this location began in the mid-1990's. This active mining operation does not provide suitable habitat for Indiana bats, and restricts the potential for Indiana bats within the action area to establish, expand, or shift their home range westward. In addition, no mist net surveys were conducted on this site prior to construction. Therefore, it its unknown whether Indiana bats have been displaced from this habitat when mining began. Indiana bat maternity colonies present within the action area may have already been adversely affected by previous mining.

Water Quality Baseline

Indiana bats use streams for drinking water, as a source forage, predating on emergent aquatic insects, and as travel corridors. Over 25 miles of streams occur in the action area. Of these streams, 6.9 miles have been directly impacted by previous mining. An unnamed tributary of Sandlick Creek, where valley fills 9 and 10 of the Black Castle Contour permit are proposed, shows very poor water quality, with very low pH values, and high concentrations of sulfates, magnesium, aluminum, and manganese that exceed the ranges recommended for freshwater organisms (application for Black Castle Coal Company's Clean Water Act permit). Near the utmost headwaters of Sandlick Creek, where valley fill 11 is proposed and near where bat # 3351 was captured, showed good water quality with near neutral pH values. All chemical water quality constituents, with the exception of magnesium, were within the ranges recommended for freshwater organisms. There are also four water treatment ponds within the Sandlick Creek drainage; although these ponds likely have impaired water quality, they could provide a forage base of aquatic insects, such as mosquitoes and midges, or drinking water for bats.

In the action area, four streams in the Sandlick Creek watershed and 10 streams in the Laurel Creek watershed have been previously filled. Existing valley fills within the drainages of proposed fills 2, 3, 4, 5, 6, 7, 8 and 10 for Black Castle Contour are currently generating acid mine drainage (AMD) as a result of the completed Black Castle mountaintop mine (S-6014-87) and completed Black Castle #3 mountain-top mine (S-6011-89). All of these valley fills are in the Laurel Creek watershed, except for valley fill 10 which is in the Sandlick Creek watershed. The acidic nature of streams from these mines has reduced or eliminated aquatic insect biomass that forms a portion of the Indiana bat prey base. The water quality of first-order streams in the Black Castle Contour permit area downstream of valley fills 2, 3, 4, 5, 6, 7 and 8 is very poor, with very low pH values and elevated concentrations of sulfates, magnesium, calcium, aluminum, and manganese, which were higher than the ranges recommended for freshwater organisms. Stations sampled for valley fills 2, 3, 4, 5, 6, 7, 8, 9, and 10 were characterized by poor macroinvertebrate populations and the absence, or poor representation, of mayflies, stoneflies, and the collector/filterer functional feeding groups, indicating serious water quality or habitat problems. There are seven water treatment ponds located within the Laurel Creek drainage. Because of the AMD and metal problems described above, these ponds are expected to exhibit poor water quality and therefore, provide very little forage for Indiana bats. Only the proposed valley fill 11 site in the very upstream headwaters of Sandlick Creek, near where bat # 3351 was captured, has a wide variety and very large abundance of mayflies, stoneflies, caddisflies, and all major functional feeding groups, indicating good water quality and excellent biotic conditions.

Larger perennial streams within the action area are Sandlick Creek and Laurel Creek, both tributaries of Hopkins Fork of the Little Coal River. Both streams are listed in WVDEP’s draft 2004 list of impaired streams, as identified under section 303(d) of the Clean Water Act. The entire length of Laurel Creek watershed is on the 303(d) list as a result of aluminum and manganese pollution. Sandlick Creek is on the list as a result of fecal coliform exceedances.

Roads in the Action Area
Roads in the action area include primary and secondary haulroads and single-lane logging roads or jeep trails. The primary haulroads are wide, graded dirt roads that are used by large trucks hauling coal to preparation plants and coal loading facilities. One primary haulroad is located in Burnside Hollow, on the north side of the proposed Laxare East mine site. This haulroad leads from a tributary of Drawdy Creek into the headwaters of Sandlick Creek and on into the Mudlick drainage, where it meets the Laurel Creek haulroad. The other primary haulroad in the action area follows the entire length of the mainstem of Laurel Creek. A secondary haulroad is located on the ridge between Laurel Creek and Sandlick Creek, and another secondary haulroad runs adjacent to Sandlick Creek.

Although a secondary haulroad occurs adjacent to most of Sandlick Creek, approximately 70 percent of the stream has forested riparian areas and could provide Indiana bat foraging habitat. The riparian area of Laurel Creek is more heavily disturbed due to a primary haulroad running the entire length. Only one bank has a forested riparian area, therefore, it is unlikely that Laurel Creek provides foraging area for the Indiana bat.

The riparian area of all proposed valley fills for the Black Castle contour site, except valley fills 7 and 8 in unnamed tributaries of George Branch, have forested riparian zones on both banks that are more than 59 feet wide. The riparian vegetation is dominated by eastern hemlock (*Tsuga* *canadensis)*, yellow poplar, and beech. The deciduous canopy provides nutrient input to the stream and provides a food base for macroinvertebrates. Previous mining, recent logging and road building has occurred in the George Branch watershed, causing negative impacts to potential foraging areas for the Indiana bat.

Indiana Bat Population within the Action Area

Maternity Activity

While emergence count data have documented that a minimum of four Indiana bats are present within the action area, a precise estimate of the number of maternity colonies, the total number of individual Indiana bats, or the size of maternity colony(ies) present within the action area is difficult due to the limited amount of data that have been gathered. However, as discussed below, it is apparent that at least one maternity colony is present in the action area.

As stated above, most maternity colonies have been discovered through the initial capture of only one or two reproductively active females. For example, mist-netting in August 1994 resulted in the capture of a post-reproductive adult female and a juvenile Indiana bat along the East Fork of White Lick Creek in Indiana. By July 1999, continuing studies in that area had documented a colony consisting of at least 146 bats (Service 2002).

A capture of a reproductive (pregnant, lactating or post-lactating) female indicates that a colony of females is in the area because Indiana bats are obligate colonial roosters (Humphrey et al. 1977; Clark et al. 1987; Gardner et al. 1996, Britzke, 2002). That means female bats congregate together to raise their young. Although there are probably many advantages to colonial roosting, the likely most important factor for Indiana bats is for the thermoregulatory benefits (Humphrey et al. 1977; Kurta and Murray 2002). Involant pups and adults in late pregnancy are poor thermoregulators (Speakman and Thomas 2003), and pre- and postnatal growth is controlled by rate of metabolism and body temperature (Racey 1982). Without clustering together, the strict thermal conditions needed to support prenatal and postnatal growth would not be available. Thus, colonial roosting is a life history strategy adopted (like many other temperate zone bats) by Indiana bats to improve their reproductive success (Kunz and Lumsden 2003). Therefore, the capture of female Indiana bats in reproductive condition, within the project area provides reasonable certainty at least one maternity colony is present in the action area (further described below).

Each Indiana bat that was captured within the action area in 2003 had a separate, closely clustered set of 2 or 3 roost trees that were used consistently for 9 to 11 days demonstrating that each bat had site fidelity to a separate roost area, referred to as the eastern and western roost area. Indiana bat use of the western roost area was documented again in 2004. Reproductive female bats will disperse from the primary maternity roost and preferentially use alternate roosts after young are capable of flight, however they still remain in the established maternity area prior to migration. In the action area, each bat showed fidelity to a different cluster of alternate roosts during the late phase of their reproductive period, suggesting separate colonies. These two groups of roost trees were two miles apart. Callahan et al. (1997) evaluated three Indiana bat maternity colonies and found that the smallest circle that would encompass all roost trees for those colonies was 0.5 miles, 0.65 miles, and 0.92 miles. These distances are smaller than the distances between the two roosting areas on site. Therefore, the BA (Apogee 2004a) concluded that the two captures could represent two different maternity colonies. While this conclusion is reasonable, as discussed below, further investigation of past habitat degradation and additional surveys have led the Service to believe that it is more likely that the captures represent the fragmented remnants of a single colony in decline.

The Service's assumption that one maternity colony is present within the action area is based on the following information. Currently, 25 percent of the action area has been subjected to previous mining activities. This mining is assumed to have adversely affected any previous colonies in the area by displacing them from portions of their established home range, limiting the availability of suitable Indiana bat foraging and roosting habitat, and degrading water quality within previous foraging ranges. Mining impacts are concentrated in the areas surrounding the Black Castle Contour within the Laurel Creek watershed. The existing East of Stollings permit has limited available habitat to the west of the action area. However, the habitat surrounding Sandlick Creek remains largely intact, particularly within the proposed Laxare East permit. This area currently consists of a large, unfragmented block forested habitat, and contains eight intermittent/tributary streams of Sandlick Creek and two tributaries to Morgan branch. These types of habitats are preferred foraging areas for Indiana bats (Butchkoski and Hassinger 2002; Gardner et al. 1991b; Cope et al. 1978). All the roost trees identified within the action area have been located within forested habitat adjacent to tributary streams of Sandlick Creek. Mist net surveys confirm that this area had the highest catch per unit effort for bats overall. Therefore, in the absence of the proposed projects, the area encompassed by the Sandlick Creek watershed and the Laxare East permit could provide foraging and roosting habitat suitable to support an Indiana bat maternity colony.

In addition to the existing habitat perturbations, follow-up mist net surveys in 2004 (Apogee 2004b) yielded only one lactating Indiana bat in close proximity to the individual captured in 2003. While this new survey data is not comprehensive, in combination with the degraded habitat conditions, it is reasonable to infer that the baseline condition may represent a severely reduced maternity colony that has experienced fragmentation. In other words, habitat perturbations for the last couple of decades may have severely reduced the number of colony members in the action area through a reduction of foraging and roosting habitat in the surrounding area.

Geographic extent of maternity habitat analysis (Eastern and Western Roost Areas)
For this analysis, two-mile radii were established around each of the two identified roost areas. Because these two areas could represent the focal point of the colony, each area was evaluated separately. The roost area for Indiana bat #3351 was located on the site of the proposed valley fill C of the Laxare East permit area, near an unnamed tributary of Sandlick Creek. The radius around this area will be referred to as habitat available around the "western roost area" of the action area (Table 14 and Figures 4 and 5). The roost area for Indiana bat #3352 was located immediately adjacent to a tributary of Sandlick Creek that is proposed to be filled as part of valley fill G of the Laxare East permit. The radius around this area will be referred to as habitat available around the "eastern roost area" of the action area (Table 15 and Figures 4 and 5). Rationale for the use of a two-mile radii around the roost areas is provided below.

In order to determine the potential foraging and roosting habitat available to the colony around the action area, data regarding reported distances that Indiana bats travel between foraging areas and roosts were reviewed. Although Indiana bats have been found to travel large distances overnight or from capture sites (Kurta et al. 2002; Murray and Kurta 2004; ESI 2001), we focused our review on studies documenting linear distance between roosts and core foraging ranges for female bats within their maternity area (Gardner et al. 1991a; Murray and Kurta 2004; Garner and Gardner 1992; Butchkoski and Hassinger 2002; Sparks et al. in press). For example, a female Indiana bat in Pennsylvania traveled over 12 miles in one night while making trips back and forth between the roost and core foraging area which were only 1.5 miles linear apart. Linear distances between roosts and foraging areas for females ranged from between 0.3 miles to 5.2 miles, although most distances were less then half that maximum distance (Murray and Kurta 2004; Sparks et al. in press). For example, the maximum distance listed above was reported for one individual at a colony in Indiana. However, when 41 bats from this colony were tracked, the mean distance was 1.86 miles.

Given the wide distribution of the species, there are variable habitats utilized by the Indiana bat throughout its range. Therefore, it is not surprising that there are large differences in home ranges. Murray and Kurta (2004) and Sparks et al. (in press) speculated that the variations in distances to foraging areas were due to differences in habitat type, interspecific competition, and landscape terrain. Therefore, studies from areas near the action area and in forested or mountainous habitats (Canoe Creek, PA) may be more representative of the bats' behavior in the action area. In Canoe Creek, Pennsylvania, an area with significant changes in elevation, distances between roosts and foraging areas ranged from 1.5 miles to 2.8 miles, with an average distance of 2.1 miles (Butchkoski and Hassinger 2002). During that study, no Indiana bats traveled over adjacent mountains (Brush and Lock Mountains). Seventy-eight percent of the area within the 2.8-mile radius was forested, with all bats foraging in the largest block of contiguous forest (3212 acres). Areas of more fragmented habitat were not used. Consequently, establishing radii around roost sites may over-estimate the area actually used by that colony. Most studies reported distances less than those reported for Canoe Creek. Based on this review, we determined that evaluating a 2-mile radius around each roost area was a reasonable estimate of area potentially available to the colony for foraging and roosting (Figure 4). This number is consistent with the analysis presented in the BA (Apogee 2003).

The Service recognizes that establishing a radius around alternate roost trees may not accurately estimate the habitat available to the bats; however, in the absence of more detailed site specific information on primary roost tree locations or foraging areas, this appears to be the most reasonable approach. Given that we have identified clusters of roost trees, the probability that a primary tree is close by or that these areas represent a focal point for the colony is greater than if we only had identified one tree. Also, establishing a two-mile radius around known roost areas creates a four-mile diameter circle. This distance would encompass the majority of the reported distances that Indiana bats have traveled between roost trees or between roost trees and foraging areas.

Maternity Colony Population Size in the Action Area
Maternity colony size is generally estimated through emergence counts; however, the results of these types of studies must be used with care. Emergence counts often underestimate the true

size of a colony since counts from a single tree or a single day may not represent the full number of bats present within the maternity colony as a whole and similar to this case, the colonies' primary roosts or the majority of alternate roosts may not have been identified or monitored simultaneously. As discussed in the "Life History Section" section above, emergence counts have documented maternity colonies ranging between 16 and 384 individuals (Whitaker and Brack 2002). Most documented maternity colonies have less than 100 adult female bats, and average maternity colony size in Indiana is estimated to be approximately 80 female bats (Harvey 2002; Whitaker and Brack 2002). The Service also reviewed available emergence count data from known maternity colonies in states outside the traditional "core maternity range" or adjacent to West Virginia. The Service located emergence count data for 13 maternity colonies in Kentucky, North Carolina, Tennessee, Vermont, New York, and West Virginia. Average maternity colony size based on this analysis was 81 bats. This number is consistent with the average figure of 80 female bats as was reported by Whitaker and Brack (2002).

As previously described, it appears that the maternity activity in the action area has been suppressed as a result of previous mining impacts. As a result, this Opinion assumes that the actual number of female Indiana bats is much less than that suggested in what the literature would lead us to expect in this habitat. Therefore, the Service has estimated that it would be reasonable to expect the number of Indiana bats in the action area is approximately 20-40 females based on current conditions and survey data. Additionally, young (up to one juvenile per year per female bat) and male bats are would be expected to be present if reproduction is still occurring.

Summary of Indiana Bat Status in the Action Area

The capture of three reproductively active female Indiana bats during mist net surveys conducted within the action area indicates maternity activity in the area. Maternity activity within the action area is believed to have already been adversely affected by the removal of potential foraging and roosting habitat, including the possible removal of established roost trees. While suitable roosting and foraging habitat remains in the action area, it is assumed that previous activities have severely reduced the viability of maternity activity, rendering the existing population to remnants of a single maternity colony consisting of 20-40 female bats and their young.

Conservation Needs of the Indiana Bat in the Action Area

As previously described, the maternity colony level could be an effective conservation management unit for the Indiana bat. On that basis, it is imperative that every effort should be made to allow for the persistence of the maternity colonies in the action area. Based on the site fidelity of the Indiana bat in returning to maternity habitat and the colonial nature of the species, the capture of reproductive female Indiana bat(s) in the upper portion of the Sandlick Creek watershed in two subsequent years indicates that maintenance of adequate roosting and foraging habitat in this area is critical to maintain the possibility of persistence of Indiana bat maternity activity in this general area. Further, based on the best available information, it appears that previous impacts have impaired the current Indiana bat roosting and foraging habitat throughout the action area. Therefore, in order to maintain foraging habitat in the Sandlick Creek watershed, additional stream impacts should be limited to stream reaches that have already been impaired

Additionally, in order to gain a better understanding of the ability of a maternity colony to adapt to the loss of ecosystem process and function, it is imperative to design an adequate conservation and monitoring program to ensure the possible persistence of maternity activity in the general area.

EFFECTS OF THE ACTION

In general terms, the overall population decline of the Indiana bat is a result of mortality exceeding recruitment (*i.e.*, deaths are outpacing recruitment). The specific reasons for this dynamic remain unknown. Due to the energy demands associated with migration and maintaining hibernation, higher mortality rates can be expected during these events than during routine foraging and roosting activities in summer habitat. The annual cycle (for females) of hibernation > spring migration > birthing > lactation > fall migration > mating > hibernation, can be broken at any point, resulting in the loss of that female from the population, and her remaining reproductive potential from the population. At some point(s) in this annual cycle, the species is experiencing higher mortality rates, or lower reproductive success than it did historically, causing the species' population to continue to decline (between approximately 1990 and 2000, a 19 percent decline in the range-wide Indiana bat population occurred). Since bats are only capable of producing one pup per year, this limits their ability to rebound after these population losses. The vulnerable point(s) in this cycle may differ by geographic area, and even within the same area. It is important to recognize that it is not necessarily the events in the annual cycle that are causing the species decline, rather, it may be a change in the environments (i.e., hibernacula, summer habitat, migration habitat) in which those events are occurring. Unless a change in these environments occurs to allow reproduction to exceed mortality, the species will continue to decline. The continuing population decline provides the context for the evaluation of the effects of the proposed action.

Maternity colonies are discrete reproductive units that are critical to Indiana bat survival and recovery. As discussed in the "Environmental Baseline" section, maternity activity – in the form of the remnants of a single maternity colony – has been identified in the action area. Limited data specific to the action area and the maternity colony are available to determine the current roosting and foraging habitat used by these bats, or evaluate the quality of foraging and roosting habitat currently available. Table 2 (see "Description of the Proposed Action") provides an overview of anticipated environmental effects as a result of these projects. The effects of the two mining projects are considered together, rather than separately, because these projects constitute a single action under consultation, and their effects on habitat are similar. Assessing the effects of this project is complicated by the past, recent, and other ongoing activities that have eliminated or removed a large portion of habitat within the area (see "Environmental Baseline").

The following discussion describes how the proposed action will alter aquatic and forested habitats in the action area, and then evaluates the significance of these changes to the biology and behavioral patterns of the Indiana bat. The relevant biological and behavioral factors important to these evaluations are the species' population dynamics, life cycle, philopatric behavior, and foraging and roosting requirements. The degree of habitat loss associated with the proposed projects, when combined with the environmental baseline, represents a significant change in the summer environment for the maternity colony in the action area. The biological question is how and to what extent these changes will affect individual bats within a maternity colony, and the overall viability of the colony.

Uncertainty

The primary question facing the Service in determining the extent of effects of the project is whether, and under what conditions, an Indiana bat maternity colony is able to relocate to other suitable habitat in response to destruction and/or degradation of its current maternity habitat. Although there has been no experimental or observational research directed at this question for the Indiana bat, the information standard identified under Section 7(a)(2) requires that both agencies "shall use the best scientific and commercial data available" in making determinations under Section 7(a)(2).

While there is ample scientific information specific to the Indiana bat that establishes the species' strong site fidelity to maternity habitat and the importance of colonial roosting behavior, there is limited species-specific, scientific and commercial information relating directly to the impacts of significant habitat loss. Despite the presence of this scientific uncertainty, the ESA nevertheless, requires the agency to make determinations based on the statutory information standard. To address the uncertainty associated with incomplete, or conflicting scientific information for a species, the Service's standard practice is to review scientific literature for surrogate species, as well as to seek opinions from species experts from other Service Regions, state agencies, academia, and consultants. In this situation, there exists abundant literature for numerous other bat, bird, and mammalian species who exhibit similar behavioral patterns. The Service's information standard requires evaluation of these surrogate species to assess and correlate probable impacts to the subject species. Consequently, after reviewing the available information on the Indiana bat and the behavioral responses of many surrogate species under this standard, many Service experts believe that these behavioral traits render the Indiana bat particularly vulnerable to destruction and/or degradation of maternity colony habitat. However, other Service experts believe that individuals in a maternity colony can move to other maternity habitat in response to habitat destruction and/or degradation with less than serious impacts to the maternity colony.

Due to the importance of this question to our determination of effects and because of the scientific uncertainty surrounding this question, we conducted an additional internal, independent agency review of our effects analysis and also sought the opinions of non-agency experts regarding the issues of scientific uncertainty. The agency experts who reviewed our effects analysis included bat experts and section 7 policy experts from across the country.

As can be expected in applied biology, consensus is not apparent on every issue. When synthesis of the scientific literature, surrogate species information, agency expert opinion, and non-agency expert opinion do not support consistent biological determinations, it is incumbent upon the Service to utilize the best professional judgment of Service experts to consider the weight of scientific authority along with the expert opinions and the basis for those opinions in making its determinations under section 7. This is the process and information standard the Service used in assessing the effects of the proposed action and the conclusion of this biological opinion.

Project Impacts to Forested Habitat

As discussed in the Baseline section, approximately 25 percent of the action area (1,462 acres) has been or is currently being mined (through a combination of contour, deep, and valley fill mining). Construction of the proposed action will result in the loss of an additional 2,200 acres (3.5 square miles) of forested habitat, resulting in 63 percent of the action area being converted into mined land. Approximately 2189 acres of forested habitat will remain within the 5,850 acre action area after project completion.

A total of approximately 427 acres of forested habitat that will remain after project completion are located in approximately 13 separate, fragmented, narrow strips of land following the contours between the Black Castle Contour mine and previously mined areas. According to the maps provided in the BA, these strips of remaining habitat are not connected to each other, or to forested stream corridors or other features that would provide flyways for Indiana bats to travel from these areas to other potential foraging or roosting areas. Many species of bat, including the Indiana bat, follow tree-lined paths rather than cross large, open areas (Carter 2003, Chenger 2003, Gardner et al. 1991b; Murray and Kurta 2004). Therefore, the presence of forested commuting corridors between roosting and foraging areas appears to be an important feature in determining whether an area is suitable to support Indiana bats (Murray and Kurta 2004). Studies in Michigan have documented that Indiana bats in a maternity colony never crossed open areas (open wetland or agricultural fields), and followed tree lines or fencerows to reach foraging areas, even though it required more energy and increased commuting distance by 55 percent (Murray and Kurta 2004) . As noted above, in areas with significant changes in elevations, Indiana bats appear to restrict their foraging to large blocks of contiguous forest and avoid smaller fragmented wooded areas (Butchkoski and Hassinger 2002).

The forested habitat remaining in these areas, in addition to being fragmented, would also be surrounded by mining activities. As described in the “Effects of Noise and Vibrations” section, Indiana bats may abandon or avoid using areas in close proximity to heavy equipment and blasting. Garner and Gardner (1992) further indicate that areas surrounded by significant acreage of strip mine or barren land should be considered unsuitable for the Indiana bat. As a result of these factors, these 427 acres will most likely be unsuitable to support the Indiana bat.

In addition, after project completion, approximately 490 acres of the 2,189 acres of forested habitat remaining within the action area will occur along narrow riparian corridors adjacent to Laurel Creek and its tributaries, Mudlick Fork and Stolling Fork. These areas are outside the permit boundaries but within the buffer zone established around the permits. Indiana bats have been known to use fragmented riparian corridors (Clark et al 1987; Humphrey et al 1977). However, similar to the forested areas that will remain around the Black Castle Contour, these areas will be surrounded by mining and will be subject to impacts as described in the “Effects of Noise and Vibrations” section. Also, as noted in the “Baseline” section, Laurel Creek is already affected by mining and resulting poor water quality. Sampling stations within the watershed have shown very low pH values, poor macroinvertebrate populations, and elevated concentrations of sulfates, magnesium, calcium, aluminum, and manganese. Additional water quality impacts from the proposed mining as discussed in the “Project Impacts to Aquatic Habitats” section are anticipated. These impacts will impede the ability of these streams to provide suitable drinking water or prey base suitable to support the Indiana bat. Furthermore, mist net surveys have been conducted at 13 locations within the Laurel Creek watershed. No

Indiana bats were caught during these surveys, and these stations had reduced numbers of species and individuals caught when compared to the sites located within the Sandlick Creek watershed. As a result, these 490 acres most likely do not currently support Indiana bats, and are not likely to support Indiana bats after project completion.

Approximately 370 acres of the 2,189 acres of forested habitat remaining will be along Sandlick Creek. One Indiana bat (#3352) was caught in this area. Therefore, we know that Indiana bats are already using this area for foraging and commuting. Indiana bats seem to use forested stream corridors as preferred foraging and commuting areas (Hobson 1993; Humphrey et al. 1977; LaVal and LaVal 1980; Butchkoski and Hassinger 2002; 3D/E 1995). Indiana bats have also been known to continue to use even fragmented riparian corridors (Clark et al 1987; Humphrey et al 1977). Given these factors, and the species' documented site fidelity (see "Life History" section), is it likely that Indiana bats will attempt to continue to use this area for foraging and potentially roosting. Similar to the area that will remain along Laurel Creek, the riparian area of Sandlick Creek will be surrounded by mining and will be subject to impacts as described in the *Effects of Noise and Vibrations* section. However, Sandlick Creek's riparian area would be less fragmented and wider (up to approximately 1,600 feet) than the corridor that will remain along Laurel Creek. Therefore, the impacts may be less severe in this area. All of Sandlick Creek's tributaries and headwaters will be at least partially filled by valley fills associated with the two proposed projects. Sandlick Creek will therefore be heavily affected by the indirect impacts as described in the "Project Impacts to Aquatic Habitats" section. Mining associated with the Laxare East project is expected to begin towards the headwaters of Sandlick Creek and move downstream over the life of the project. Therefore impacts to Sandlick Creek and the remaining riparian area may be relatively minor at first, but will increase over time, making the area successively less and less suitable to support Indiana bats.

Approximately 280 acres the 2,189 acres of forested habitat remaining in the action area will be between Mudlick Fork and the headwater tributaries of Sandlick Creek. This area is located in close proximity to both the capture site and the roost trees for Indiana bat # 3351 (western roost area). As a result, Indiana bats could be expected to use the area. At least initially, the area would be connected to the 370 acres along Sandlick Creek. However, as mining progresses under the Black Castle Contour project, this area would become fragmented from that parcel. Additionally, the area is bordered by Laxare East to the north, Black Castle Contour to the east and west, and by previous mining projects to the south. It will therefore be subject to similar effects as described for the Sandlick Creek area. Streams and other travel corridors will be filled and cleared. The area will be fragmented and isolated from other forested areas. These effects may be relatively minor at first, but will increase over time, making the area successively less suitable to support Indiana bats.

The final 615 acres of forested habitat out of the 2,189 acres that will remain in the action area is composed of a corridor located along the northern border of the proposed Laxare East project outside the permit boundary but within the buffer zone established around the permits. This area will be subject to impacts as described in the "Effects of Noise and Vibrations" section. In addition, some of this remaining habitat will consist of narrow wedges of habitat bordered by mining. As discussed above, Garner and Gardner (1992) suggest that if greater than 11 percent of the area within 0.6 miles of site is strip mine or barren land then the area should be considered unsuitable for the Indiana bat. However, this area is also adjacent to a larger block of intact forested habitat that is located outside the action area, that is currently not proposed for mining. This factor may partially ameliorate the severity of the potential adverse effects to this area. As a result, at least some of this habitat is expected to remain suitable to support Indiana bats. As mining on the proposed Laxare East project progresses eastward over time, greater and greater expanses of active or recently reclaimed mine lands will separate this area from the known Indiana bat foraging and roosting areas that have not yet been cleared. Since Indiana bats appear to avoid crossing large open expanses of land during maternity activity (Murray and Kurta 2004; Sparks et at., in press), western portions of this habitat will become successively unavailable to any Indiana bats remaining on site.

In summary, after completion of the proposed action approximately 2,189 acres of forested habitat will remain within the 5,850 acre action area. However, approximately 427 acres of forested habitat remaining adjacent to the Black Castle Contour will become unsuitable due to fragmentation and impacts from adjacent mining. Another 490 acres adjacent to Laurel Creek and its tributaries Mudlick Fork and Stollings Fork will become or already is unsuitable due to demonstrated lack of Indiana bat useage, fragmentation, impacts from adjacent mining, and poor water quality. This results in 78 percent of the action area being unsuitable for Indiana bats after project construction. The remaining forested habitat (1,285 acres or 22 percent of the action area) is primarily located either adjacent to Sandlick Creek or north of the Laxare East project. These areas will also be degraded due to adjacent mining impacts including reduced water quality, disturbance from adjacent mining, and fragmentation. These areas may remain suitable to support Indiana bats at least in the early stages of the mining projects. As mining progresses, however, these areas will become progressively degraded and/or isolated from existing Indiana bat roosting and foraging areas making them increasingly less suitable to support Indiana bats.

Effects of Noise and Vibration

In addition to habitat destruction, the proposed action will result in a decrease in the quality of remaining habitat outside the actual project footprint. Increased disturbance in the action area is anticipated from blasting and the use of heavy equipment as the mountain tops are removed and the valleys are filled. As a result, Indiana bats in the action area will be exposed to noise levels, or intensity of noise and vibrations that they may not have experienced in the past, depending on the proximity of their roost sites to past mining activities nearby. Because mining activities that generate noise will occur day and night, roosting and foraging bats may frequently be disturbed.

Blasting can result in rocks and gravel being thrown several feet from the blasting area. It is likely that blasting and debris will reduce the suitability of nearby habitat and disturb any bats using those areas. Increased noise, blasting, and vibrations may cause disturbance to Indiana bats unaccustomed to these impacts while roosting and thereby lower the suitability of adjacent habitats. It is difficult to predict the degree to which Indiana bats would be disturbed by these impacts associated with mining activities. Some studies suggest that bats may be able to tolerate loud noises. Indiana bats were documented to use roosts near the I-70/ Indianapolis Airport area, including a primary maternity roost tree that was located 1,970 feet south of I-70. This roost was not abandoned despite constant noise from the Interstate and airport runways. However, their use of areas in such close proximity to the Interstate could also have been due to lack of a more suitable roosting area, as this study area is highly fragmented and there is limited forested habitat remaining (Service 2002). Other studies suggest that bats avoid noisy areas. Female bats in Illinois used roosts at least 1,640 feet from paved roadways (Garner and Gardner 1992). Callahan (1993) noted that a roost tree was abandoned after a bulldozer cleared brush in the area. It is therefore reasonable to conclude that noise and vibrations related to mining activities could result in bats abandoning roosts in close proximity to mining and blasting, and/or cause bats to not select new roost trees in close proximity to these activities.

There is limited data available on how far away from noise and mining tree roosting bats need to for these effects to be avoided, in the absence of this data we used other available standards. Noise generated from blasting is expected to cause vibrations that may result in damage to structures as far away as 0.7 miles. In West Virginia, the Department of Environmental Protection requires that landowners within 0.7 miles of blasting must be contacted due to the potential impacts to structures (Ratcliff, personal communication, West Virginia Department of Environmental Protection). In Pennsylvania, the Department of Environmental Protection (PA DEP) prohibits blasting within 300 feet of an occupied structure (Pennsylvania Code, Title 25, §87.127). In addition, the PA DEP requires that surface mine operators notify landowners within a 0.5-mile (2,640 feet) radius of the permit area prior to blasting, and that the operator conduct a pre-blasting survey of the condition of dwellings within that radius, upon the request of the residents or owners of the structures (Pennsylvania Code, Title 25, §87.125). These requirements indicate that blasting could have an effect as far away as 0.7 miles. This distance is similar to the 0.62 mile distance used by some researchers to evaluate how land use characteristics affect the suitability of an area to support Indiana bats (Garner and Gardner 1992). Based on these standards, it is reasonable to conclude that adverse effects to roost trees and any Indiana bats using these trees, especially pups, may occur within 0.7 miles of mining.

Project Impacts to Aquatic Habitats

Headwater streams and riparian areas are expected to be lost through the burial of streams, creation of on-stream sediment ponds, and conversion of the stream channels between the toes of the valley fills and the sediment ponds into drainage ditches. Additionally, indirect impacts to receiving streams are expected for an unquantifiable distance downstream. The following information regarding the concern over the loss of aquatic ecosystem function as a result of valley fills is taken directly from Howard et al. (2001):

> Recognizing that aquatic resources of a stream ecosystem are a reflection of its surrounding landscape and land uses (Minshall et al 1985), concerns arise when rugged, steep terrains covered by deciduous forest typical of the Central Appalachians are replaced by gently rolling hills and pastures. Non-woody organic matter, originating from densely-forested streams has been identified as the major energy base of aquatic ecosystems (Vannote et al. 1980, Cummins 1980, Merritt et al. 1984). Deforestation, an environmental liability associated with mountaintop mining operations, would naturally affect the organic inputs to the energy budgets of aquatic ecosystems. Disruptions in the biological processes of first- and second-order streams impact not only aquatic life within the stream, but also the functions that aquatic life contribute to downstream aquatic systems in the form of nutrient cycling, food web dynamics, and species diversity (Cummins 1980, Merritt et al. 1984).

Direct Stream Loss

Direct loss of existing stream habitat as a result of the creation of valley fills, drainage ditches and sediment ponds is one of the major impacts associated with the proposed action. As discussed in the Baseline section, there are approximately 25 miles of stream within the action area. Previous mining has directly impacted 6.9 miles (27%) of streams in the action area through the creation of valley fills. The Laxare East project would impact 6.95 miles of streams through construction of valley fills, sediment ponds, and associated mining. An additional 5 miles of streams are proposed to be impacted by the Black Castle Contour project. This will result in the loss of a total of 11.95 miles of streams from the action area, leaving 6.45 miles of streams intact. The Corps describes some of these impacts to be "temporary" since sediment ponds and other features will be removed once the valley fills are constructed. However, the Service has not differentiated between these two types of impacts. Although some of the stream impacts are described by the applicant as temporary, the loss of stream habitat is expected to persist for many years, along with the associated adverse effects to Indiana bats. Consequently, because reforestation and stream restoration efforts are not likely to restore forested riparian areas and functioning stream corridors within the lifespan of the project (see "Effects of Conservation Measures" section), both permanent and temporary stream losses as described in the Corps' Public Notices for the proposed project will have similar effects in regard to the Indiana bat, and are considered long-term.

As a result of the combined impacts of previous mining and the currently proposed action, 75 percent of the stream length within the action area has been or will be directly impacted by mining activities. The loss of stream habitats coupled with the loss of associated riparian forested habitats, will eliminate preferred foraging areas, as well as bat flyways, and watering areas. In addition, the loss of riparian areas is expected to greatly reduce the foraging efficiency of Indiana bats because riparian areas have been shown to provide a much higher volume of insects.

Indirect Stream Impairment

In addition to the direct loss of insect production in the headwater reaches as described above, indirect downstream effects could occur because of the possible degradation of water chemistry, and increase in sedimentation, and the probable loss of energy in-puts to downstream reaches, and changes in the temperature and flow regime. These impacts would further reduce prey availability and make the water less suitable as a drinking water source.

<u>Water Chemistry</u>

Because insects associated with aquatic habitats make up part of the diet of Indiana bats, water quality can affect the prey base of the species. As described in Wallace (2004), the base chemical composition of unpolluted streams draining a landscape is established in headwater streams (Gibbs 1970; Likens 1999; Johnson et al. 2000). An important mechanism controlling the export of nitrogen from watershed is the biotic uptake by vegetation, and the transformation by microbes in soils, riparian zones, and streams. The presence of carbon is critical for this process. Headwater streams are the sites of the most active uptake and retention of dissolved nutrients (Alexander et al. 2000; Peterson et al. 2001). Therefore, the burial of headwater streams results in an increase in the downstream transport of nutrients which increases the concentration of chemicals in downstream reaches.

Studies conducted for the draft Environmental Impact Statement on Mountaintop Mining/Valley Fills (Bryant and Childers 2002) found that, when compared to reference streams, streams downstream of valley fills generally had higher conductivity, sulfate, calcium, magnesium, hardness, total dissolved solids, manganese, selenium, potassium, nitrate/nitrite, and alkalinity or acidity. These studies found that benthic macroinvertebrate communities generally showed decreased diversity, reduced or absent pollution-sensitive species, and increased pollution-tolerant species downstream of valley fills when compared to reference streams (Howard et al. 2001; Green and Childers 2000). For example, Howard et al. (2001) found that mayflies (pollution-sensitive) were either absent or rare downstream of valley fills, while reference stream benthic populations were comprised of 49 to 66 percent mayflies. At the same time, the percentage of members of families Chironomidae and Oligochaetes (pollution-tolerant) increased. Generally, these changes were strongly correlated with the increased conductivity downstream of valley fills; conductivity may be a surrogate for other chemical parameters. It is possible that changes in insect type or in seasonal availability of particular insects may lead to shifts in nutritional quality of the bats' diet; or that bats may leave the riparian corridors in search of an alternate, upland food source. Even upland food sources are likely to be reduced after forested habitat is removed by logging and mining activities. As described in the "Maternity foraging behavior" section, foraging efficiency is thought to facilitate development of young by reducing the amount of energy expenditure in foraging. A reduction in foraging efficiency may have adverse effects on the ability of an adult female to nurture young of the year. As further discussed in the "Foraging Habitat Loss" section, in addition to a reduction to the aquatic prey base, insect abundance in the uplands will be decreased too (Owen et. al. 2004). These losses in prey base will contribute to the "harm" caused to the bats as described above in the "Direct Stream Loss" section.

In West Virginia, selenium contamination has been associated with the impacts of mining and valley fills (Bryant and Childers 2002). Studies on birds, fish and mammals have shown that selenium can cause teratogenic and congenital deformities such as missing or deformed body parts (Friend and Franson 1999; Lemly 1999); and changes to the liver heart, kidney, and spleen (Eisler 1985). Bioaccumulation of selenium generally occurs from water to invertebrates (Ohlendorf 2003; Mason et al. 2000), therefore species such as the Indiana bat, that eat benthic macroinvertebrates, may be subject to increased risk from selenium toxicity. The Service has previously found that high levels of selenium associated with mining activities may pose an ecological risk to fish in West Virginia (Service 2004a). We have not located any baseline data on selenium concentrations in streams downstream of the proposed Laxare East and Black Castle mining operations. However, if mining causes selenium to become elevated to concentrations above water quality standards within the action area, Indiana bats may be exposed to toxic levels when eating benthic macroinvertebrates from these streams, thus further reducing their overall fitness and ability to produce healthy offspring.

<u>Sedimentation</u>
Various studies (Howard et al. 2001; Wiley et al. 2001) have demonstrated that sedimentation increases downstream of valley fills. Fine-grained sediments can reduce benthic invertebrate populations by smothering organisms or eliminating essential habitat. Substrate particle size is often cited as one of the critical factors for stream invertebrate populations as finer particle sizes are indicative of more instability as well as lower invertebrate biomass (Hynes 1970; Minshall

1984; Allan 1995). Reduced benthic invertebrate populations would lead, in turn, to a reduction in adult insects and a reduced prey base for the Indiana bat, which will contribute to other water quality and habitat loss factors causing “harm” to the bats through decreased fitness, malnutrition and starvation.

Loss of Energy Sources to Downstream Reaches

The following information regarding the loss of energy sources is taken from Wallace (2004). Headwater streams draining eastern deciduous forests in the Central Appalachians receive most of their energy inputs from leaves, wood, etc. supplied by the surrounding forest. Organic debris dams in headwater streams provide sediment and organic matter retention, along with habitat structure and sites for metabolic activity (Steinhart et al. 2000). Most of the energy or food resources for downstream aquatic organisms will be lost as a result of the loss of the organic detritus input from the headwater streams. As a result of physical abrasion, microbes, invertebrates (Wallace et al. 1991), and organic matter from the surrounding forest are processed into fine particulate organic matter and dissolved organic matter (Meyer et al. 1998). This organic matter serves as food for, among other things, downstream invertebrates. As a result of the valley fills, the headwater streams will no longer serve as a source of input, storage, and conversion of organic matter for export to downstream areas. The ultimate result will be lower instream productivity in downstream reaches and ultimately the loss, or severe reduction of prey resources for the Indiana bat.

Changes in the Temperature and Flow Regime

In areas below valley fills a higher baseflow is maintained than typical forested headwater streams (Wiley et al. 2001). This is largely as a result of the absence of evapotranspiration because of loss of the hardwood forest (Swank and Crossley 1988). This will result in excess loading of chemicals, and also exacerbate conductivity which will have adverse effects on downstream aquatic organisms (Allan 1995; Wallace and Webster 1996). In addition to directly harming downstream aquatic organisms as a result of chemical loading, there is a potential increase in flooding, which can be detrimental to downstream organisms, and alter dynamics of both nutrients and organic matter in downstream reaches (Allan 1995; Wallace and Webster 1996). Also, recovery from floods by aquatic species may take up to a year or more following flooding (Hoopes 1974; Molles 1985), or up to two years following massive flooding (Wallace 2004). Alteration of the natural flow regime, either from a higher discharge below valley fills which results in a higher baseflow, or elevated flood flows can be expected to adversely affect downstream macroinvertebrate abundance and diversity.

Water emerging from valley fills has low daily temperature fluctuation and reduced seasonal temperature variations as compared to similar unmined streams (Wiley et al. 2001). Thermal regime is one of the most important influences on life cycles of aquatic organisms, and seasonal fluctuations characterize most undisturbed stream environments (Ward and Stanford 1982; Sweeney 1984). Life history traits of aquatic invertebrates, including larval growth, adult size and adult fecundity, may be influenced by both food and temperature (Anderson and Cummins 1979; Vannote and Sweeney 1980). In addition, as a result of dependence on natural temperature variations for successful completion of their life cycle, many stream invertebrates have evolved to depend on these natural temperature variations. Thus, reductions in daily and seasonal temperature fluctuations will likely reduce or change stream invertebrate composition and abundance.

Impacts to Aquatic Habitats - Summary

There are approximately 25 miles of streams within the action area. Previous mining has directly impacted 6.9 miles of these streams and the proposed project will directly impact an additional 11.95 miles. These combined impacts will result in 75 percent of the streams within the action area being directly impacted by mining. The loss of stream habitats coupled with the loss of associated riparian forested habitats, will eliminate preferred foraging areas, as well as bat flyways, and watering areas. Because insects associated with aquatic habitats make up an important part of the diet of Indiana bats, loss and degradation of these habitats can also adversely affect the prey base of the species.

Remaining streams downstream of the valley fills and sediment ponds will be degraded as a result of indirect effects. Studies conducted for the draft Environmental Impact Statement on Mountaintop Mining/Valley Fills (Bryant and Childers 2002) found that, when compared to reference streams, streams downstream of valley fills generally had decreased water quality and impaired benthic macroinvertebrate communities. Increased concentrations of contaminants in these streams could adversely affect Indiana bats through bioaccumulation or by reducing the available prey base. Downstream stream reaches will also be affected by increased sedimentation, lower instream productivity, and disruption of natural flow and temperature regimes. These impacts will further degrade remaining foraging habitat and reduce the availability of prey for the Indiana bat.

As a result of these losses and degradation of aquatic habitat, it is anticipated that some bats will suffer “harm” (i.e., actual death or injury) through decreased fitness as energy expenditures are increased to attempt to compensate for lost and degraded food and water sources. As food and water sources are eliminated, foraging bats will be forced to seek new habitat and expand their foraging range. Their foraging will be less successful in unfamiliar habitat and expose bats to increased predation, and increased intra- and interspecific competition with both resident and other displaced bats resulting in “harassment.” As the bats’ energy expenditures increase with simultaneous decreases in food and water supplies, both adult females and nursing juvenile bats are expected to have increased susceptibility to failed pregnancies, and delayed volancy and maturation of pups, causing malnutrition and starvation for dependant young and their mothers.

Project Impacts to Indiana Bat Biological and Behavioral Factors

This section describes how the anticipated impacts to aquatic and forested habitats as described above, will affect the biological and behavioral factors important to the Indiana bat. Factors to be considered include the species’ population dynamics, life cycle, philopatric behavior, and foraging and roosting requirements.

Roosting Habitat Loss

An important feature of Indiana bat behavioral biology that is integral to the discussion of effects of the proposed projects is the fact that female Indiana bats exhibit site fidelity to summer roosting and foraging areas (see “Life History”). That is, Indiana bats return to the same summer range annually to bear their young (Kurta and Murray 2002; Kurta et al. 2002; Garner and

Gardner 1992;Gardner et al. 1991b; Humphrey et al. 1977; Gardner et al. 1996; Cope et al 1973; Sparks et al in press). Indiana bats may migrate up to 300 miles from their hibernacula to their maternity areas, and members of one maternity colony may come from many different hibernacula (Kurta and Murray 2002; Gardner and Cook 2002). The Indiana bat's site fidelity may serve to allow members of a maternity colony to relocate each other and regroup in the spring. Telemetry studies on a maternity colony in Indiana have indicated that Indiana bats continue to return to areas that previously served as foraging habitat, even after those areas have been developed and no longer provide suitable habitat (John Whitaker, personal communication). This information indicates that when these Indiana bats return to their summer range, they will attempt to use the same roosting and foraging areas that were used in previous years. While evidence suggests that maternity colonies are evolutionarily adapted to the loss of a specific maternity tree, there is also evidence that this exacts a demographic cost, especially in the context of a large scale alteration of the landscape that supported the roost site, roost trees and foraging habitat (Kurta and Murray 2002; Pierson 1998; Racey and Entwistle 2003).

It is likely that due to the ephemeral nature of roost trees, the Indiana bat has evolved to be able to relocate replacement roosts when their previously-used roost trees become unsuitable (see "Life History" section above). Studies have shown that adults in maternity colonies use multiple roosts (Humphrey et al. 1977; Gardner et al. 1991a; Garner and Gardner 1992; Callahan 1993; Kurta et al. 1993a; 3D/E 1995). Bats that are aware of alternate roost sites are more likely to survive the sudden, unpredictable destruction of its present roost than the bat which has never identified such an alternate (Kurta et al. 2002; Kurta and Murray 2002; Gumbert et al. 2002). It appears that when a primary roost tree falls, members of the colony may initially distribute themselves among several previously used alternate roost trees, and the colonies become more dispersed (Service 2002; Kurta et al. 2002; Indianapolis Airport Authority 2003). It is not known how long it takes for the colony to attain the same level of roosting cohesiveness that it experienced prior to the loss of a primary roost tree. Until the bats from the colony locate another desirable primary roost tree and reunite, it is likely that individual members of the colony will be subject to increased stress resulting from: 1) having to search for a replacement primary roost tree(s); 2) having to roost in alternate trees that are less effective in meeting thermoregulatory needs; and 3) having to roost singly, rather than together, which decreases the likelihood in meeting thermoregulatory needs, thereby reducing reproductive success. The use of sub-optimal roosts has been shown to result in reduced reproductive success in other bats species such as the big brown bat (*Eptesicus fuscus)* (Kunz and Lumsden 2003).

It is not known how long or how far female Indiana bats will search to find new roosting habitat if their traditional roost areas are lost or degraded. While some researchers speculate that bats may simply move to other areas and that this will not affect the colonies' ability to regroup or successfully reproduce (Gardner *in* Service 2004c), other researchers have stated that bats may not be able to compensate if a large number of trees used in previous years are missing. One long-term study of an Indiana bat colony in Indiana concluded that loss of critical roosting areas may cause considerable stress to Indiana bats (Indianapolis Airport Authority 2003). A similar study in Michigan lead researchers to conclude that "destruction of many roost trees in a small area could be devastating when these bats faithfully return the following spring" (Kurta et al. 2002; Kurta and Murray 2002). If Indiana bats are required to search for new roosting habitat in the spring, "adult females are faced with finding suitable maternity sites at a time when they are already stressed from the rigors of hibernation, migration, and the increased energy costs of pregnancy" (Garner and Gardner 1992). For these reasons, Gumbert et al. (2002) suggest that managers should retain all roost trees used by Indiana bats and Kurta and Murray (2002) suggest that the use of seasonal tree-clearing restrictions is not a sufficient stand-alone measure to minimize impacts to Indiana bats. Humphrey et al. (1977) concluded that maintenance of "traditional summer homes are essential to the reproductive success of local (Indiana bat) populations." Pierson (1998) noted that landscape alterations can have "profound impacts" on populations of bat species that demonstrate loyalty to roosting and foraging sites. Since Indiana bats likely discover their roost trees within foraging areas or along commuting corridors, Kurta (in press) suggests that any large-scale modification of habitat that includes destruction of foraging sites would be particularly detrimental.

As described in the "Project Impacts to Forested Habitat" section, construction of the proposed project will cause an extensive loss of maternity roosting habitat within the action area. A total of 2,199 acres (3.5 square miles) of suitable Indiana bat roosting habitat will be eliminated in the Laxare East and Black Castle Contour project areas. Potential future roost trees will not regenerate within the mined areas for decades, and given the documented lack of suitability of previously reclaimed areas (Apogee 2004c) and the success of other past reclamation efforts (see "Effects of Conservation Measures – Reforestation" section), the destruction of habitat is considered permanent. This will significantly reduce the future number of suitable roosts within the summer range of this colony. An additional 917 acres of forested habitat is expected to become or currently is unsuitable for Indiana bat foraging or roosting (See "Impacts to Forested Habitat" section). A total of 7 Indiana bat roost trees have been identified in the action area. All these trees were located within the Sandlick Creek watershed. This watershed appears to be an important area for Indiana bats within the action area. All the roost trees that have been identified would be removed by the proposed Laxare East project. During telemetry studies, one female Indiana bat (#3351) was tracked to two roost trees located near the headwaters of Sandlick Creek within the Laxare East project area. The project will eliminate this known roosting area, as well as nearby forested riparian habitats associated with the headwaters of Sandlick Creek. Additional mist net surveys conducted in the summer of 2004 confirmed that Indiana bats continue to use this area for roosting (Apogee 2004b). No other roosting areas were identified during the survey of this bat. The only roosting area identified for another female Indiana bat was located near a tributary to Orchard Branch in the eastern-most part of the Laxare East project area. The Laxare East project will also eliminate this entire roosting area, as well as most of the forest cover within the Orchard Branch watershed. Because the roost trees in each area were clustered together, it is anticipated that all known roost trees within each area will be cleared at one time. Since mining on the Laxare East project is scheduled to move west to east, the roost area identified for Indiana bat #3351 will be cleared prior to clearing bat #3352's roost area. Any Indiana bats that used these areas will be displaced from their known roost areas and will be forced to locate to new roosts. It is also possible that additional roost areas not identified in previous surveys exist in either the 2,199 acres proposed to be cleared or the habitat that will become unsuitable. Indiana bats would also be displaced from these roosts. The colony could also have additional roost areas outside of the current action area that would remain after project construction. In this case, impacts of removing roost trees would be reduced proportionate to the percentage and quality of roost trees that would remain.

Roost Tree Loss - Summary

In summary, the proposed project will not retain known Indiana bat roost trees as recommended by peer reviewed literature (Gumbert et al 2002; Kurta and Murray 2002), conversely the project proposes to remove all the Indiana bat roost trees that have been identified. At least one of these roost areas has been used by Indiana bats over two years, demonstrating that Indiana bats are exhibiting site fidelity to this area. All trees identified for each individual bat will likely be removed in one year. This impact is coupled with the additional landscape level removals of other potential roost areas. Past mining and logging in and around the action area could have previously displaced bats from other known roosts. Displaced Indiana bats will be forced to locate new roosts in the spring when they are stressed from hibernation, migration, and the increased energy costs of reproduction. Published literature suggests that large scale loss of established roosting habitat can have adverse effects on Indiana bats including reduced colony cohesion; increased stress; and increased energy demands from searching for new roost areas and decreased thermoregulatory efficiency; and that these impacts can lead to reduced reproductive success (Kurta et al. 2002; Kurta and Murray 2002; Gumbert et al. 2002; Kunz and Lumsden 2003; Indianapolis Airport Authority 2003; Garner and Gardner 1992; Racey and Entwistle 2003; Humphrey et al. 1977; Pierson 1998). The severity of these impacts could range from "devastating" (Kurta and Murray 2002) to minor (Gardner *in* Service 2004c) depending on the percentage of roost trees that will be cleared each year, and the amount of suitable roost trees that are retained outside the action area. Because clearing will take place over a number of years, the likely percentage of established roost trees that will be cleared at one time may be reduced. On the other hand, this means that Indiana bats could be displaced from known roosts for multiple, successive years causing the colony to experience decreased reproduction over a longer time frame.

Impacts from the loss of roost trees are anticipated to "harm" and "harass" individual bats in a number of ways. As discussed in the "Interspecific and Intraspecific Competition" section, the bats will be displaced into habitat that is possibly already occupied by conspecifics as well as interspecific competitors. The roost availability in these areas may be limited by the habitat itself, as well as by competition. The displaced bats will need to increase energy expenditures since they will be required to increase commuting distances to traditional foraging areas, and/or expend additional energy seeking new foraging and roost sites. This increased energy expenditure is anticipated to "harm" and "harass" individuals by affecting fitness, nutrition, and reproductive success.

Additionally, it is anticipated that loss of primary roost trees will disrupt the cohesiveness of the colony. Available information suggests that disruption will last a number of years at a minimum. The duration and extent of this disruption will ultimately determine the level of impacts to individual bats as well as the viability of the colony as functional, discrete reproductive units. Meanwhile, however, as the colony is fragmented, the individuals immediately lose some of the thermoregulatory benefits that are required for proper fetal and pup development. Colder temperatures are likely to induce torpor, more often and for longer periods with decreased colony size due to fragmentation. Torpor allows the bats to survive the immediate cold spell, but decreases fetal development and stops feeding of both pups and adults. Combined with other stresses discussed in this opinion, the thermoregulatory deficits associated with colony fragmentation will cause "harm" and "harassment" to individual bats through decreased fitness, decreased reproductive success, and lower survival rates for pups and adults. How these impacts affect the viability of the colony is discussed later in the effects analysis.

Foraging Habitat Loss

As described in the *Life History* section, Indiana bats feed solely on emerged aquatic and terrestrial flying insects (Brack and LaVal 1985; Kurta and Whitaker 1998; Belwood 1979; Service 1983). The effect of this project on aquatic insects is described throughout this Opinion. Less is known with regard to the impact of this project on terrestrial flying insects. However, it is known that much of the Indiana bat terrestrial prey base (e.g. moths, beetles, wasps, flying ants, leafhoppers, tree hoppers, etc.) are dependent upon a forested environment. One of the primary effects of the proposed project on the Indiana bat colony in the action area will be the loss of foraging habitat due to the loss of streams and forested habitat. A total of 2,200 acres of habitat will be cleared by construction of the Laxare East and Black Castle Contour projects, resulting in 63 percent of the action area being converted into mined lands that are considered unsuitable roosting and foraging habitat for the Indiana bat. The Indiana bat is dependent upon aquatic and terrestrial insects for forage. The forested habitat remaining in the action area will either become unsuitable or will become progressively degraded and isolated making it less suitable to support the Indiana bat. In addition, 11.95 miles of streams will be directly impacted from mining activities associated with the two mining projects, resulting in 75 percent of the streams in the action area being directly impacted by mining when considered in conjunction with the baseline condition. Remaining streams in the action area will be subject to the indirect effects, as described above, resulting in the change, reduction or elimination of a suitable prey base (aquatic insects) for an unquantifiable distance downstream. The combined effect of all these impacts is a reduction, or at the very least, a dramatic change in the foraging habitat available to support the Indiana bat within the action area.

Very little site specific information is available on where Indiana bats forage within the action area. However, information for females at other locations may provide a useful estimate. The foraging areas for individuals documented in the literature are variable, ranging from 96.4 to 2886 acres (Sparks et al. in press). In Illinois home ranges of up to 850 acres have been reported, however the mean range for 41 bats was 220 acres (Gardner et al. 1991a, b). The mean value for individuals from one colony in Indiana was 1018 acres (Sparks et al in press). Foraging areas for six female Indiana bats in a Pennsylvania maternity colony ranged from 96.4 to 276.8 acres in size (Butchkoski and Hassinger 2002). The latter site most closely mirrors the terrain and forest cover found in the action area. The proposed action will remove 2,200 acres of habitat and an additional 917 acres of forested habitat will be, or currently is, unsuitable for Indiana bat foraging. Remaining habitat will be degraded. Thus the project will remove an amount of habitat that is greater than the size of most of the foraging ranges documented for individual female Indiana bats (see also “Maternity Colony-size (area)” discussion). As a result, the entire home range of any Indiana bats that currently use the project area could be eliminated. Although these habitat losses will occur over time rather than simultaneously, according to the BA up to 500 acres could be disturbed at one time (Apogee 2004a). This could conceivably result in the removal of a bat’s entire home range, or a significant percentage of a bat’s home range, in one year. It is likely that all Indiana bats using the action area would be displaced from at least part of their established foraging range.

While Indiana bats may also forage in upland forests and the edges of open spaces, the data appear to suggest that Indiana bats are using the forested corridors around the headwaters, tributaries, and mainstem of Sandlick Creek for foraging. This is consistent with data from other studies suggesting that intermittent streams and riparian areas are often preferred foraging habitats (Hobson 1993; Humphrey et al. 1977; LaVal and LaVal 1980; Butchkoski and Hassinger 2002; 3D/E 1995; Owen et al. 2004). With the exception of the mainstem of Sandlick Creek, the proposed action will remove most of the forested riparian corridors and lower order streams in the action area. Owen et al. (2004) stresses the biological importance of these areas to bats, including the Indiana bat, within the central Appalachian region. Thus, it is likely that the Indiana bat's preferred foraging habitat will be removed. If some bats only forage in the project area occasionally, they should be familiar with other nearby foraging areas. These bats may be able to adjust for lost habitat by spending more time foraging in other portions of their range. For bats that foraged extensively or exclusively within the project area, the effect may be more severe. These bats may either attempt to remain in traditional foraging areas as they are degraded or will shift their foraging range into previously unused areas to make up for the loss of foraging habitat.

When Indiana bats emerge from hibernation and migrate to their summer maternity areas, fat stores are typically extremely depleted (Fleming and Eby 2003). Upon arrival at summer maternity habitat, bats must quickly restore their body weight and increase their food intake in order to support pregnancy and lactation (Speakman and Thomas 2003). However, the foraging efficiency of bats declines during pregnancy, a time when energy demands increase (Barclay and Harder 2003). If the summer range is modified such that a significant portion of the colonies' roosting habitat or foraging areas are removed, displaced bats will need to spend more time and energy traveling to distant foraging habitats and searching for suitable new areas. Increased distance to forage areas would increase the amount of energy expended. This added energy expenditure may place additional stress on pregnant females at a time when fat reserves are low or depleted and they are already stressed from the energy demands of hibernation, migration and gestation (Kurta, et al. 2002; Kurta and Murray 2002). These bats must also spend a greater proportion of their total intake on self-maintenance, and will have less energy to allocate to reproduction (Ransome 1990; Barclay and Harder 2003). As a result of these increased energy demands, individuals would face increased risk of mortality and decreased reproductive success (Ransome 1990; Barclay and Harder 2003; Tuttle and Kennedy 2002). Indiana bats may also experience higher rates of predation when searching for new foraging and roosting areas (Gumbert et al. 2002).

Some females that are not able to quickly adapt to these changed conditions and meet these increased energy demands will not survive long enough to successfully raise a pup. Bats are known to enter into temporary torpor as a survival mechanism when they are faced with adverse conditions such as energy shortfalls and food deprivation (Speakman and Thomas 2003). Torpor is a state of suspended physical activity and reduced regulation of body temperature. While this may enable the adult to survive, it would delay the development of young. Bats forced to express torpor (through food deprivation and/or low ambient temperatures) give birth later than bats not subject to torpor. Milk production is also slowed or stopped, resulting in decreased growth rates of nursing young (Racey and Swift 1981 *in* Speakman and Thomas 2003). Early parturition and rapid growth appear to be important in providing juveniles the time needed to complete growth and acquire adequate fat reserves prior to hibernation (Kunz et al, 1998b and Pagels 1975 *in* Speakman and Thomas 2003). Due to their late maturity, they will have less time to forage and build up the fat reserves necessary for fall migration and hibernation, placing them at an increased risk of mortality (Barclay and Harder 2003). Therefore, even if the adults bear live young, the additional stress of lactation will decrease the females' (and therefore also the pup's) likelihood of survival. If its mother does not survive long enough to wean the pup, the pup will also perish. Other females will successfully wean a pup, but due to the loss of roosting and foraging habitat, the pups will mature late in the season or have lower birth weights (Ransome 1990). Additionally, those with late maturing pups must continue to produce milk at a time of the year when they need to accumulate fat for migration and winter torpor. These females and their pups will also face increased mortality rates throughout fall migration and hibernation (Barclay and Harder 2003; Fleming and Eby 2003). Additional stresses to the mother and the pup make it likely that many of these young bats will not survive to successfully reproduce the following season (Ransome 1990).

In addition, in order to sustain a healthy reproducing maternity colony, the prey base must be sufficient to allow adults and juveniles to reach a particular fat:lean mass ratio to successfully reproduce (Racey 1982). Fat accumulation is necessary for juvenile survival and eventual recruitment into the breeding population. For example, literature suggests a relationship between body size and sexual maturity for some bats. In Racey (1982), Schowalter and Gunson (1979) confirmed variations in the times of puberty for the big brown bat by observing that yearling females have a lower pregnancy rate than do older females. The Indiana bat's prey base in the action area will be reduced due to the loss of insects associated with the destruction and degradation of 11.95 miles of streams and loss of 2,199 acres of upland and riparian forests (See "Project Impacts to Aquatic Habitats" and "Project Impacts to Forested Habitats" sections). Even after terrestrial areas are reclaimed, herbaceous cover will be dominant for many years post-mining, and bats are unlikely to venture far from forest cover (Murray and Kurta 2004; LaVal et al. 1977; Humphrey et al. 1977) to feed, so the effect of the loss of terrestrial foraging habitat is expected to be long-term. Unfortunately, much of the remaining suitable forested habitat (post-mining) is concentrated in nearby riparian areas (*e.g.*, along Sandlick Creek, Mudlick Fork, Laurel Creek, and Long Branch) that are likely to suffer from water quality impacts related to mining. Thus, the bats will be more dependent on the aquatic insect food base of these downstream reaches at a time when the food base may be eliminated, diminished and/or contaminated by the valley fill impacts.

There is some indication that these types of effects may already be occurring. During telemetry studies, one of the Indiana bats captured in the action area in 2003 (#3352) was tracked to a roost tree during the day. This bat was found alive but completely exposed on the ground at the base of the tree (Apogee 2004a), potentially indicating that the bat had entered a state of torpor. The apparent use of torpor in Indiana bats present within the action area may indicate that the colony has already been adversely affected by habitat alterations, the loss of prey base, and foraging habitat. Additional habitat losses could have similar or more severe affects on bats within the action area.

Documented Impacts for Other Species with Similar Life Histories

As described above, the overall effect of the loss of roosting and foraging habitat on individual bats from the colony will be lost reproductive capacity, reduced overall fitness, and reduced survival rates. While the Service recognizes that there is little quantitative data on how Indiana bats respond to large scale habitat disturbances, these predicted effects are similar to the effects documented for other species showing site fidelity. Site fidelity has been positively correlated with reproductive success in other species (Blancher and Robertson 1985). The documented benefits of site familiarity include reduction in time spent searching for new brood rearing sites, more profitable exploitation of local food resources, and greater awareness of resident predators (McNicholl 1975; Dow and Fredga 1983; Divoky and Horton 1995). Species exhibiting high site fidelity are known to be particularly sensitive to alterations of their foraging, roosting, or breeding habitats and have been shown to experience reduced productivity and substantial population declines when faced with these types of changes (Takagi 2003). Regardless of migratory ability or otherwise high mobility, particular individuals that tend to be associated with discrete habitat patches will suffer from loss of that habitat. Even if there is an ability to relocate, when individuals of species that normally exhibit high site fidelity move to different breeding locations, they may suffer decreased reproductive success following the movement (Dow and Fredga 1983).

The main feature that distinguishes bats from all other mammals is the ability to fly (Barclay and Harder 2003). In addition, very few terrestrial mammals migrate long distances (Fleming and Eby 2003). The combined factors of flight, long distance migration, and site fidelity to breeding and rearing areas, make bats unique in the mammal world. Since birds share these common biological traits, and have been extensively studied, they may be a useful surrogate for comparison of potential effects. In species with demonstrated site fidelity, such as the Northern spotted owl (*Strix occidentalis caurina*), goshawk (*Accipiter gentilis*), Steller's eider (*Polysticta stelleri*), and brown shrike (*Lanius cristatus*), adverse effects to reproduction, survival, and foraging ability have been documented when individuals continued to return to previously used sites even after the habitat had been degraded (N. Kanim, personal communication, Service; Greg Balogh, personal communication, Service; Takagi 2003).

Similar to the Indiana bat, the ability of marbled murrelets (*Brachyramphus marmoratus marmoratus*) to disperse after having their brooding habitat destroyed has been the subject of much debate. Site fidelity can either inhibit their ability to relocate after having their nest sites destroyed, or cause them to remain in areas that have become unsuitable due to increased forest fragmentation (Divoky and Horton 1995). Moreover, it appears that even if displaced marbled murrelets are able to survive and disperse, reproductive success is reduced and mortality levels are increased (Hebert et al. 2003; Peery et al. 2003). Goldeneye (*Bucephala clangula*) that were displaced from previously used brood rearing habitat have shown reduced reproductive success, and delayed hatching of young (Dow and Fredga 1983). Given that other species exhibiting similar biological and life history traits to Indiana bats have been shown to experience decreased reproductive success, increased mortality, and overall population declines when faced with alterations of traditional breeding grounds, it is reasonable and likely that Indiana bats would experience similar types of effects when faced with similar habitat alterations.

Foraging Habitat Loss - Summary

In summary, very little site-specific data are available to evaluate where Indiana bats may be foraging within the action area, however studies from other locations suggest that foraging is likely to be concentrated around forested stream corridors (Hobson 1993; Humphrey et al. 1977; LaVal and LaVal 1980; Butchkoski and Hassinger 2002; 3D/E 1995; Owen et al 2004). This type of habitat will be severely reduced within the action area as a result of currently proposed mining. Under the current project description, up to 500 acres could be disturbed at one time. This figure is larger then many foraging ranges that have been identified for individual Indiana bats, and represents a significant percentage of many others. Therefore large portions of a bat's foraging range could be removed in one year.

Remaining habitat will be degraded as a result of forest fragmentation, adjacent mining, and reduced water quality. Bats either remaining in the action area, or displaced from previously used foraging sites can be expected to have higher rates of reproductive failure, and have young that mature later – thus reducing their ability to survive fall migration and hibernation. They may also suffer from reduced foraging success, starvation, increased predation, and other stress-related mortality (Kurta, et al. 2002; Kurta and Murray 2002; Ransome 1990; Barclay and Harder 2003; Tuttle and Kennedy 2002; Gumbert et al 2002, Fleming and Eby 2003). The reproductive capacity of the maternity colony will be additionally compromised because the prey base may not be sufficient to allow adults and juveniles to reach a particular fat:lean mass ratio to successfully reproduce (Racey 1982). The anticipated impacts are similar to impacts that have been documented for other species with similar life histories when they were faced with disruptions to maternity habitats.

In summary, it is anticipated that "harm" and "harassment" to individual bats will be incurred through a variety of means. The loss of the terrestrial prey base and associated increased energy expenditure associated with loss and degradation of roosting habitat, and riparian foraging and water sources will result in overall decreased fitness of individuals resulting in death or injury directly through predation, starvation, and failed reproductive success. Additional injuries and death will occur to fetuses and pups as a result of malnutrition, reduced fitness, and death of the adult females. In turn, increased energy demands on lactating females due to delayed parturition of pups will decrease those females' fitness making them more susceptible to secondary impacts such as starvation, increased predation, and failure to successfully mate that fall.

Interspecific and Intraspecific Competition

Clearing of forested habitat will displace all bats within the project area. This includes Indiana bats, as well as all bats from a minimum of seven other species that are present within the action area. These displaced bats may move into the remaining habitat. Interspecific and intraspecific competition between displaced bats and bats within adjacent undisturbed areas may significantly increase as the displaced bats attempt to locate new roosting and foraging areas. The feeding habits of Indiana bats are similar to those of the little brown bat (*M. lucifugus*), the Northern long-eared bat (*M. septentrionalis*), and to a lesser extent the Eastern pipistrelle (*P. subflavus*) (Whitaker 2004). All three of these species were captured in mist net surveys within the action area, therefore competition between those species may be pronounced as all species are compressed into the remaining foraging habitat or move quickly into adjacent habitat. While it is unknown if any of these species has a competitive advantage over the other, Duchamp et al. (2004) found that in areas undergoing significant habitat alteration, bat species showing site fidelity to foraging areas were at a competitive disadvantage when compared to other more generalist species such as the big brown bat (*Eptesicus fuscus*). That species was the most common species captured in the mist net surveys in the action area. Although very little literature is available to assess the impact of this effect, interspecific competition has been identified as an area of significant concern by researchers monitoring maternity colonies subject to habitat alterations in Indiana (John Whitaker, personal communication). It is likely that displaced bats will experience lower survival rates when competing against other bats that have already established territories and are familiar with the area. Some studies have suggested that increased intra and inter specific competition resulting from habitat alterations can disturb colony dynamics and potentially cause the loss of local populations (Indianapolis Airport Authority 2003).

Colony Cohesion and Social Structure

As described above, individual Indiana bats are expected to experience decreased reproductive success and increased mortality as a result of the proposed action. The remaining question then, is how these adverse effects to individual bats will affect the overall health and viability of maternity colony present within the action area. The degree of habitat loss associated with the proposed projects, when combined with the environmental baseline, represents a significant change in the summer environment for the maternity colony in the action area. However, these changes will not all occur simultaneously. The effects are expected to occur over the 12 year life of these projects. As more and more of the project is completed, the bats will be progressively compressed into remaining habitats or forced to abandon or shift into other roosting and foraging areas. This may minimize impacts to the colony by allowing the colony to incrementally adjust to smaller scale, but repeated, disturbances over a number of years. Alternatively however, this may exacerbate the impacts as bats will be forced to repeatedly relocate and adjust to increasingly more severe habitat losses. Under this scenario, the proposed action is likely to cause reduced reproduction and increased mortality over a number of years, creating a long-term decrease in maternity colony population.

Further, the expected loss of individuals and reduced reproduction resulting from colony relocation may create a negative feedback loop, in that each loss of a member will result in additional adverse impacts to remaining members. As colony size decreases, the thermoregulatory and communal benefits experienced by the remaining bats will be decreased (Barclay and Harder 2003**;** Racey and Entwistle 2003). Without clustering together, the strict thermal conditions needed to support prenatal and postnatal growth may not be available. The potential exists that there may be a loss of these communal benefits below a threshold colony size (Racey and Entwistle 2003; Indianapolis Airport Authority 2003). Under these conditions, the remaining bats would experience even greater energy demands and reduced fitness than anticipated and described under the "Roosting and Foraging Habitat Loss" sections. Consequently, the colony may be less able to offset natural causes of mortality through yearly production of offspring. For each female and each pup that dies along with its reproductive potential, the maternity colony population will not only steadily decrease each year, but because of the limited recruitment potential of this species (Racey and Entwistle 2003),will be less able to recover to original maternity colony size.

If Indiana bats are subjected to decreased reproduction and increased mortality over the life of the project, and the life of the project is expected to exceed the average lifespan of a healthy Indiana bat, then recruitment to the colony may not be sufficient to replace mortality. In large colonies, there may be sufficient population numbers to maintain a colony for a number of years under these conditions. However, smaller colonies, or colonies that have already been subjected to previous losses as is suspected for the colony located within the action area, may not have sufficient numbers to withstand this type of impact. It is unknown whether there is a minimum number of bats that are needed for a colony to be successful (Indianapolis Airport Authority 2003). Once a colony reaches some low level threshold, it may no longer be viable (Sparks *in* Service 2004c). However, some females may continue to be found at the site for several years before the colony fully disappears (Macgregor *in* Service 2004c). While the relationship between viable population size and species colonality is poorly understood, it is recognized as an important component of Indiana bat behavior (Racey and Entwistle 2003; Callahan 1993; Gardner et al. 1991b; Neuweiler 2000).

As described in the "LIFE HISTORY - Social Structure" section, Indiana bats are believed to maintain a "fission-fusion" society (Kurta et al. 2002). This type of society has a fluctuating composition with many members of a colony residing in one tree at any one time, while other members depart to form small subgroups or roost individually for a time before returning to the main group (Barclay and Kurta in press). However, all members of a colony may maintain social interactions. The benefits of colonial roosting (fusion) may include increased predator protection; thermoregulatory and energetic benefits; and communication regarding important foraging and roosting areas (Kurta et al 2002; Barclay and Kurta in press; Willis and Brigham 2004). The reasons for fission reactions are not clear but may be related to fluctuating or patchy food availability (Barclay and Kurta in press).

It appears that big brown bats (*Eptesicus fuscus*) share this same type of social structure. In that species, multi-year loyalty to roost areas and to roosting associations between individual bats within a colony have been identified (Willis and Brigham 2004). The management implications of this study suggest that the definition of a bat "roost" should be expanded to include roosting areas within a forest, and that activities that would remove a majority of trees within that area could make much of that "roost" unavailable. Willis and Brigham (2004) further state that management of these roost areas as discrete entities is necessary to ensure the stability of bat populations. This conclusion for big brown bats is similar to the conclusion reached by researchers engaged in multi-year research of an Indiana bat colony in Indiana. That study suggested that loss of critical roost areas could change Indiana bat colony dynamics (Indianapolis Airport Authority 2003).

These studies suggest that large scale removal of established roost and foraging areas as proposed by this project could disrupt the social bonds of a colony. These disruptions could decrease the ability of the colony members to locate each other when they return in the spring; increase susceptibility to predators; increase energetic costs associated with thermoregulation; and reduce fitness through use of sub-optimal roosting and foraging areas. Large scale removal of habitat could also make the overall area unsuitable to support a maternity colony (Willis and Brigham 2004), cause the colony to be lost (Indianapolis Airport Authority 2003), and/or cause the colony to break up into smaller groups (Indianapolis Airport Authority 2003; Barclay and

Kurta in press). It is possible that individual colonies would merge, however studies on other *Myotis* species suggest that this does not occur (Racey and Entwistle 2003).

As noted in the Baseline section, the capture of multiple reproductively active female Indiana bats during mist net surveys conducted within the action area in 2003 indicates that at least one maternity colony is present in the area. The continued presence of a maternity colony was confirmed by the capture of an additional reproductively active female Indiana bat in 2004. Limited site-specific emergence count data are available to estimate the size of the maternity colony located on site. Based on data available from other sites, it is estimated that maternity colonies on average consist of approximately 80 adult female bats. However, numbers of bats within the colony in the action area may actually be lower than this figure. Previous mining in and around the action area may have already adversely affected the colony by disturbing roosting and foraging habitats, reducing prey availability, and potentially fragmenting the colonies.

The proposed project will result in landscape level alterations to roosting and foraging habitat within the action area, including removal of all currently known roost trees and a large percentage of preferred foraging habitats. Individual Indiana bats are expected to experience decreased reproductive success and increased mortality as a result of the proposed action. There is uncertainty about what percentage of the colony's home range (including roosting and foraging habitat) will be disturbed over the life of the project or in any one year. It is therefore difficult to determine severity or extent of the anticipated adverse effects. Given the limited amount of data available to evaluate how a colony may react to large scale habitat disturbances, it is not known whether colony within the action area will be lost, or will under go a fission reaction as a result of the proposed action. However, the best available information on the impacts of habitat loss to other species that also exhibit site fidelity and colonial behaviors similarly suggests that large scale habitat loss could have catastrophic impacts to individual Indiana bats and colonies. After considering the reduced colony size that is suspected within the action area, and the cumulative total of all the anticipated adverse impacts to individual bats within the colony, it is likely that the colony does not have sufficient population to withstand reduced reproduction and increased mortality over an extended duration and these impacts will result in the colony being extirpated.

Analysis of Adjacent Habitat

Due to the uncertainty regarding the fate of colonies when faced with large scale maternity habitat alterations, the Service held a meeting with a number of Indiana bat researchers on July 20-23, 2004 at the National Conservation Training Center (Service 2004c). Many researchers suggested that Indiana bat colonies could adapt to the loss of 10 percent of their home range in one year, but that the severity of the impact would depend on what part of the home range was taken. The ability of a colony to adapt to additional losses in subsequent years would depend upon whether there was a sufficient amount of suitable forested (foraging and roosting) habitat in adjacent areas for the bats to move into (Sparks, Kurta, Currie, Clawson, and Gardner *in* Service 2004c).

The biological assessment (Apogee 2003a) used aerial photography and Autocad 2002 to calculate the percentage of forested and non-forested habitat within a two-mile radius of each roost area. The Service used that information, along with information about adjacent projects already permitted, and the anticipated effects of the proposed action to determine the amount and percent of forest cover and available stream habitat reflecting the environmental baseline, as well as post-project conditions. Additional acreage calculations were conducting using an ARCINFO GIS system. Tables 14 and 15 provide a general overview of anticipated effects to Indiana bat habitat for the western and eastern roost areas, respectively. It should be noted that there are other active permits within each two-mile radius in addition to the two proposed actions. Because these permits are ongoing, losses within the two-mile radii can be greater than the losses anticipated from the proposed actions. There is also some overlap between the two established radii. There are approximately 8,040 acres within each two-mile radius.

While this analysis focuses on percent forested cover, it should also be noted that all the models available for evaluating the suitability of an area to support Indiana bats require that multiple variables be analyzed (Farmer et al. 1997; 3D/International 1995; Garner and Gardner 1992). These other variables include percent canopy cover; availability of food and water; density of snags and other suitable roost trees; and average dbh of trees. Inadequate information is available to analyze these other variables within the two-mile radius evaluation areas. In addition, none of these models includes other factors such as level of disturbance, water quality, and the large scale disruption of ecological processes, that are germane to evaluation of the impacts from mountaintop removal mining activities. Therefore, while the evaluation of whether an area meets or does not meet the recommended percent forest cover values is useful, it is not a sufficient stand-alone measure to determine whether the available habitat is sufficient to support Indiana bat maternity activity. It is likely that the areas currently being used by the Indiana bat were chosen by the colony because a suite of appropriate conditions were present. It is unknown whether these conditions are replicated in other areas in or adjacent to the action area.

Western roost area

Table 14. Habitat conditions for the western roost area

	Current	Project Effects	Post-project
Forested habitat (% of area with forest cover)	4802 acres (60%)	-1867 removed	1844 acres (23%)
Streams	18.5 miles[1]	-10.7 miles	7.8 miles

[1] Includes effects as a result of previous permits that have authorized the loss of 12.1 miles of the original 30.6 miles of streams within this radius.

Currently, 60 percent (4,802 acres) of the area within a two-mile radius of the western roost area is forested. Mining on the Laxare East and Black Castle Contour permit areas will remove approximately 1,867 acres of forest in this radius. Adjacent mining will remove an additional 1,091 acres leaving 23 percent (1,844 acres) of the area within the range of this roost area remaining as forested habitat. Most of the remaining forested habitat will be concentrated around the mainstem of Sandlick Creek and north of the Laxare East project.

As described previously, additional patches of forested habitat located between Black Castle Contour and already-mined areas and around Laurel Creek will be so small, isolated, or degraded that they will probably not provide suitable Indiana bat habitat. Therefore, only 927 acres of suitable forested habitat will remain for the western roost area, should it continue to roost near Sandlick Creek or its tributaries. As a result, only 11 percent of the habitat within this two-mile radius will remain as potentially suitable forested habitat. These percentages are less than the 30 percent threshold identified by 3D/International (1995). Further, 77 percent of this radius will be mined lands. This is much higher than the threshold indicated by Garner and Gardner (1992), which states that if over 11 percent of the area within 0.6 miles of a roost site is strip mine or barren land then the area should be considered unsuitable to support Indiana bat maternity activity. Farmer et al. (1997) indicated that optimal summer habitat has 20-60 percent forest cover within an area with a 0.6-mile radius, and that areas with less than 5 percent forest cover within this radius are not suitable for Indiana bats. Given the smaller scale recommended by these evaluation measures, and the extent of mining proposed, it is likely that an inadequate amount of forest cover will be available to support maternity activity in the western roost area after mining is completed.

Of the 30.6 stream miles that occur within a two-mile radius of the western roost area, mining-related disturbance to 12.1 miles has already been permitted. The proposed project will remove an additional 10.7 miles of streams, along with their associated forested riparian areas. Following project completion, 75 percent of the stream miles in the range of the western roost area will be directly affected (filled or impounded) by mining. These streams and their associated forested riparian areas are important areas for bat foraging and prey production. Remaining streams will be adversely affected by the surrounding mining. The elimination and degradation of these and adjacent streams (see “Impacts to Streams” section) will degrade bat foraging and watering areas, and reduce their prey base.

Eastern roost area

Table 15. Habitat conditions for the eastern roost area

	Pre-project	Project Effects	Post-project
Forested habitat (% of area with forest cover)	6662 acres (83%)	-1469 acres	4436 acres (55%)
Streams	26.6 miles[1]	-9.0 miles	17.6 miles[1]

[1] Includes effects as a result of previous permits that have authorized the loss of 4.6 miles of the original 31.2 miles of streams within this radius.

Currently, 83 percent (6632 acres) of the area within a two-mile radius of the eastern roost area is forested (Table 15 and Figures 4 and 5). Mining on the Laxare East and Black Castle Contour permit areas will remove approximately 1,469 acres of forest in this radius. Adjacent mining will remove an additional 757 acres, leaving 55 percent (4,436 acres) of the area within the range of this roost area remaining as forested habitat. In addition, forest fragmentation resulting from the Black Castle Contour project, in combination with the past effects of clearing other mined areas, is expected to isolate numerous strips of forested habitat. These patches will probably be so small and isolated that they likely will not be used for foraging since Indiana bats avoid flying over large open expanses. However, a large block of contiguous forested habitat consisting of approximately 2,490 would remain to the northeast of the Laxare East project.

After project construction over 45 percent of the area within a two-mile radius of the eastern roost area will be mined. This is much higher than the threshold indicated by Garner and Gardner (1992), which states that if over 11 percent of the area within 0.6 miles of a roost site is strip mine or barren land then the area should be considered unsuitable to support Indiana bat maternity activity. However, the 55 percent remaining forest cover is greater than the 20 and 30 percent thresholds suggested by Farmer et al. (1997) and 3D/International (1995) respectively. Therefore, sufficient forested cover may remain to support Indiana bats within this evaluation area. As noted above, there is no information available to evaluate whether this remaining habitat meets the recommended thresholds for other characteristics required to support Indiana bats. However, based on the aerial photography it appears that the habitat is these areas is similar to habitat within the Laxare East permit area that is known to currently support bats.

Of the 31.2 stream miles that occur within a two-mile radius of the eastern roost area, mining-related disturbance to 4.6 miles has already been permitted. The proposed project will affect an additional 9.0 miles of streams, along with their associated forested riparian areas. Following project completion, 44 percent of the stream miles in the range of the eastern roost area will be directly affected (filled or impounded) by mining. These streams and their associated forested riparian areas are important areas for bat foraging and prey production. Remaining streams will be adversely affected by the surrounding mining, resulting in further reductions in available prey base and degradation of remaining bat foraging areas.

Other Major Mining Projects within Adjacent Habitats

While overall West Virginia is 78 percent forested (USDA 2004), Boone County is the most heavily mined county in the state (West Virginia Coal Association, 2003). Over 10,000 acres of surface mining was permitted in the county between 1997 and 2002 alone (West Virginia Coal Association, 2003). Further, a significant amount of surface mining is concentrated around the Williams Mountain quadrangle which includes the action area. In addition to the previous mining that has been discussed in the Baseline section, three additional active surface mines occur immediately adjacent to the action area within the two-mile radius evaluation areas (see Figure 4). The West of Stollings permit is an approximately 1,087 acre mine, located to the southwest of the proposed action area. This permit will impact a total of 8,265 feet (1.56 miles) of stream. The Lexerd permit is located to the south of the action area and consists of 837 acres, and will impact 22,521 feet (4.26 miles) of stream. Mist net surveys were conducted within these project areas during the same time frame that the surveys were conducted on the Laxare East and Black Castle Contour projects. While no Indiana bats were caught during the surveys on these additional projects, construction of these two projects, concurrent with the proposed action, will eliminate or severely reduce the possibility that suitable forested and aquatic habitats will be available in adjacent habitats to the south or southwest of the action area for Indiana bats to move into once they are displaced.

The East of Stollings mine is a currently active mine of approximately 1,238 acres that is located immediately adjacent and to the west of the action area. The presence of this permit eliminates the possibility that suitable forested habitat will be available in adjacent habitats to the west of the action area for Indiana bats to move into once they are displaced. These three mines will eliminate a total of 3,162 acres of habitat immediately adjacent to the action area, and will restrict the available adjacent habitat to the south, southwest and west of the action area. The presence of these mines further amplifies the importance of the forested habitat located to the northeast of the currently proposed action.

Analysis
The ability of bats within the western roost area to adapt to the currently proposed loss of habitat is questionable. It is likely that insufficient forested or aquatic habitat will remain at this location to support a colony. Bats currently using this area would be fully displaced from the majority of their home range over the life of the project. Under current mining plans, mining in the Laxare East project would progress from west to east. Bats using the western roost area of the project would be forced into remaining habitat to the east; however, this habitat would be disturbed in subsequent years. These subsequent disruptions would cause reduced reproduction and increased individual mortality that would continue for many successive years. The colony would likely be lost, or undergo additional fragmentation when faced with the loss of many roost trees, decreased habitat availability, successively reduced prey base, increased degradation of remaining foraging habitat, and increased intra and interspecific competition. If the colony's focal point is at this location, the colony would likely become non-viable, or be extirpated over the life of the project. If the colony's focal point is located around the eastern roost area location, bats within the colony would also be displaced from at least part of their home range; however, sufficient forested habitat may exist in adjacent areas to allow these bats to adjust and shift their home range into new areas. Under this scenario, the colony would still suffer significant reductions in size, reduced colony cohesion, reproduction, and individual fitness, however there is a potential that the colony could survive these impacts and remain in some reduced capacity.

Other large mining projects exist to the south, southwest and west of the action area that restrict the availability of adjacent forested habitat that displaced bats could move into. One large block of contiguous forest remains to the northeast of the action area. This is most likely the area that displaced Indiana bats would attempt to colonize if they attempted to remain in the area but were displaced from portions of their home range within the action area. It is unknown whether this area has the characteristics necessary to support maternity activity. With the exception of the mist net studies that were conducted on the Lexerd and West of Stollings permits, the Service is not aware of any surveys that have been conducted for Indiana bats within these remaining adjacent areas. It is possible that these adjacent areas are already occupied by other colonies of Indiana bats, and that these colonies would be impacted by displaced Indiana bats moving into their established home ranges. However, no conclusions can be made about this potential without additional survey data.

Secondary Impacts to Hibernating Populations
As a result of the reduced numbers of bats present within the maternity colony resulting from anticipated impacts of the proposed project, there will also be a reduction in the number of bats returning to hibernacula. Since studies indicate that it is unlikely that all of the bats from a maternity colony come from the same hibernacula, it is reasonable that from one to several bats, from the colony within the action area may migrate to, mate, and hibernate at one of several hibernacula within the known migration range of the bat (Kurta and Murray 2002; Gardner and Cook 2002). Indiana bats may migrate up to 300 miles from their hibernacula to their maternity areas (Kurta and Murray 2002; Gardner and Cook 2002). As shown in Figure 6, there are

numerous hibernacula surrounding Boone County, West Virginia that are within the migration range of the Indiana bat. The closest known Indiana bat hibernacula are located approximately 50 to 80 miles from the action area (Apogee 2004a). The hibernacula that contribute bats to a colony are referred to as “source hibernacula”. Because the hibernating source populations for the maternity colony in the action area are not known and can not be determined at this time, specific impacts can not be quantified, but following types of effects are anticipated.

When a female fails to return to her hibernaculum or does not survive through the hibernation period, the size of the hibernating population is reduced. This is magnified by the loss of her unrealized reproductive potential (i.e., lost progeny that will never be part of or contribute to that hibernating population, or any other hibernating population). There are several advantages to being a member of a large hibernating population. Clawson et al. (1980) suggests that the “substantial metabolic advantages” of large clusters, and the bats’ clustering behaviors, may buffer populations within individual hibernacula from extinction. Additionally large populations benefit from the social and energetic (thermoregulatory) advantages of hibernating in dense clusters; congregating for spring staging; and having many individuals available during fall swarming to ensure reproductive success.

A reduction in the numbers of bats present to swarm, mate, and cluster within a source hibernacula (especially at a priority III hibernaculum) may place the remaining bats at a physiological disadvantage. These remaining bats may be more susceptible to changes in temperature, rapid arousal, and extreme stress during hibernation, thus causing a reduction in survival or reproduction (Clawson et al. 1980). Reductions in the numbers of bats present in the source hibernacula may further aggravate the current decline in the overall Indiana bat population. Ransome (1990) states that when evaluating the causes of population declines in bats, a reduction in the number of maternity colonies contributing to a hibernaculum is a prime factor that should be considered.

Effects of Conservation Measures

When used in the context of the ESA, “conservation measures” represent actions proposed by the Federal action agency that are intended to further the recovery of and/or minimize or compensate for project effects on the species under review. Because conservation measures are pledged in the Project Description by the applicant and/or action agency, their implementation is required under the terms of the consultation.

The applicant has incorporated the following conservation measures into the proposed project:

1. Seasonal tree cutting restrictions;
2. Post-mining reforestation;
3. Post-mining stream restoration;
4. Installation of bat boxes and watering sources on reclaimed mine lands; and
5. Leave summer habitat on the lower slopes for both the mountaintop removal and contour mine projects, and on the upper slopes for the contour mine projects.

The following analysis evaluates the potential benefits of these conservation measures in relation to the proposed project’s adverse effects as described above.

Seasonal tree-cutting restrictions
The applicant proposes to avoid directly killing or injuring roosting bats by removing trees between November 15 and March 31, when Indiana bats are likely not roosting in trees in the action area. During this window of time, Indiana bats are hibernating; therefore, no bats will be directly killed or injured due to the felling of trees.

However, the applicant also requested that approximately 290 acres of forested habitat be cleared between mid-April and the end of May, 2004. However, since the proposed time period of clearing outside the hibernation period (April to May 2004) has past, we assume that all acreage within the action area would be cleared during the hibernation period (November 15 and March 31), and direct killing of adult bats and their young would be avoided through full implementation of this conservation measure.

Despite the assumption that seasonal clearing restrictions will be implemented, the following discussion outlines the potential effects of implementing tree clearing outside the hibernation period as originally proposed. Of the 290 acres that the applicant wanted to clear outside the hibernation period, 210 acres are located in the western portion of the Laxare East project and 80 acres are located within the Black Castle Contour project area along Georges Branch and its tributaries. It is unknown whether this area contains any established Indiana bat maternity roost trees. None of the seven known Indiana bat roost trees are located within this area, however, to date, only limited telemetry data of three reproductively active female Indiana bats has been collected. These surveys were conducted for a short period of time and do not cover the entire maternity period (9 to 11 nights each). Tracking of these bats may only represent a sub-set of the total number of Indiana bats present on-site and the colony likely has additional primary and alternate roosts that have not yet been identified (see "Baseline" section). Surveys conducted in 2004 did not include any mist net locations in these areas, and only two mist net sites were located in these areas in 2003. It is therefore, possible that this area contains additional roosts that have yet to be documented

The removal of forested habitat presents an immediate risk to any Indiana bats that are roosting in the area when the trees are cut. Tree cutting generally occurs during the day, when Indiana bats are roosting under the bark or within crevices or splits of dead, dying, or live trees. Limited information suggests that some of the Indiana bats would remain in the roost tree until after it is felled (Craig Stihler, personal communication), and that some bats will survive the impact of the fall and then attempt to crawl or fly out of the tree and seek cover elsewhere (Belwood 2002). Any bats on the underside of the tree will likely be injured or killed when the tree falls to the ground. Unlike the Belwood (2002) situation where the fallen tree was not immediately limbed and cut up for processing, bats at this mine site will have little time to reorient and escape prior to the onset of additional impacts. Additional tree felling and the operation of heavy equipment (log skidders) in the vicinity of felled trees will likely further reduce the survival of those bats. Therefore, those bats that survive the fall of their roost tree are likely to be killed or injured while attempting to escape and seek cover elsewhere. Surviving bats will also be subject to an increased risk of predation, and exposure to adverse environmental effects until they are able to find another suitable roost tree. If they move to a nearby tree for cover (*i.e.*, a tree located within the 290 acres to be cleared), they will again be exposed within a short period of time to another repetition of significant risk of death or injury as that tree is also felled, limbed, and skidded out of the forest.

The risk of tree cutting to bats may be slightly less in April and early May, when the bats are migrating between their hibernacula and summer habitat. However, Indiana bats have been documented to arrive in maternity areas as early as late March or during April (John Whittaker personal communication; Susi von Oettingen, personal communication). Regardless, by mid-May they are usually established in their summer habitat (Indianapolis Airport Authority 2004; Britzke et al. 2003; Britzke et al. 2004). Cutting trees in late April and May will increase the risk of affecting pregnant females, as well as any adult males present. The death of a pregnant female would result in the take of two Indiana bats (the adult female as well as her fetus), affecting both the size and reproductive potential of the colony. Injury to a pregnant female may result in injury to, or death through spontaneous abortion of her fetus, also resulting in a reduction of the colony's reproductive potential.

Due to the potential for direct take of Indiana bats from cutting potential roost trees when the bats are present, seasonal clearing restrictions have been consistently implemented within known maternity areas. Implementation of this measure has generally been practicable, and the Service is not aware of any previous Biological Opinions that have exempted tree clearing outside the hibernation period within known Indiana bat maternity areas.

Reforestation

The proposed post-mining land use for the Laxare and Black Castle Contour project areas is forestland. However, reforestation activities will not provide suitable Indiana bat habitat for many years after project completion, if at all. The applicant proposes to place a minimum of six inches of topsoil or topsoil substitute material over the re-graded area, followed by disking, grading, tracking-in, or scarifying prior to planting. The BA specifies that lime will be applied to achieve a soil ph of 6.0, application of 10-20-10 or 10-20-20 fertilizer at a rate of 600 lbs/acre, and placement of wood fiber, wood cellulose, or shredded bark mulch. White pine and red oak would be planted at a rate of 450 stems per acre. The BA also specifies a mix of perennial ground covers.

The *Draft Programmatic Environmental Impact Statement on Mountaintop Mining/Valley Fills in Appalachia* (U. S. Environmental Protection Agency 2003) noted that a number of commonly-used reclamation techniques, many of which are designed to minimize erosion and provide backfill stability, are incompatible with re-establishment of trees. Twenty years of reforestation research at Virginia Tech's Powell River Project has identified a number of past mistakes that have inhibited tree growth on reclaimed mines, including over-compacting the backfill, selecting an inappropriate rooting medium, failing to salvage and redistribute native plant material, neglecting to match tree species habitat preferences to site-specific conditions (such as aspect, spoil type, etc.), and planting highly competitive ground covers (Burger and Zipper 2002).

Unfortunately, it appears that the Laxare and Black Castle projects are proposing some of the same reclamation methods that have been identified as inhibiting reforestation, and will not lead to the re-establishment of tree species that would provide future habitat for Indiana bats. The proposed mix of two tree species will not create a biologically diverse, healthy forest ecosystem. The proposed six inches of topsoil or topsoil substitute is not deep enough to allow establishment of trees (four feet of topsoil is needed). In addition, grading and tracking-in will lead to over-compacted soils that will inhibit tree growth, and there is no provision to salvage native plant materials. Also, the proposed application of a perennial herbaceous seed mix after an initial, temporary herbaceous planting, will result in multiple passes by planting equipment further exacerbating the already compacted soils.

It would be decades before any trees would reach a sufficient size and condition to be used as a maternity roost. It may also be decades before sufficient tree cover is established to serve as foraging habitat, although even then, the quality of the foraging habitat is likely to be less than pre-project habitat due to loss of streams and tree species diversity. Even if mature forest cover is eventually established, this would be well after other project-associated effects (as detailed above) would have resulted. Effects that occurred during active mining of the project areas would have likely resulted in the displacement of the maternity colony. Therefore, forest restoration would only benefit maternity activity still extant in these watersheds when the reclaimed areas become suitable for foraging or roosting.

Stream restoration
Streams and their associated riparian forested habitat provide preferred foraging areas, bat flyways, and watering areas for the Indiana bat. Owen et al. (2004) found that forested riparian habitats are biological import to bats within the Appalachian region. The streams proposed to be impacted by this project provide habitat for the aquatic life stages of numerous flying insects that become prey for many species of wildlife, including the Indiana bat. Additionally, the loss of intermittent/ephemeral headwater streams is expected to adversely affect receiving streams that are known to provide aquatic prey base for the Indiana bat (see “Indirect Stream Impairment” Section).

The BA indicates that stream mitigation plans are still under development in consultation with the corps. Conceptually, the plan would involve creating intermittent streams on the down-dip side of the mining area by transforming on-bench sediment cells at the lowermost seam of mining into a meandering stream with riffles and pools. Ephemeral streams will be created in the center drain of valley fills. In-stream ponds will be removed and the streams restored after mining is completed. The BA does not indicate whether the length of created waterbodies will equal the length of the destroyed streams.

The mitigation plans appear to be predicated on the conclusion that the streams that will be filled for this project are all ephemeral or intermittent, as stated in the public notice. The BA’s stream disturbance tables show stream impacts more than a mile long (*e.g.*, Right Fork of Sandlick Creek) classified as intermittent/ephemeral. A study of 37 stream segments in West Virginia conducted for the draft Environmental Impact Statement on Mountaintop Mining/Valley Fills found that perennial streams begin in very small (median 41 acres) watersheds. In addition, the applicant’s Corps permit application for the Black Castle Contour permit states that the streams upstream of all the proposed fills except one (fill 4) “would support a fisheries community throughout the year”. This further supports that the proposed fills would occur within perennial streams.; The creation of intermittent streams in sediment cells and ephemeral drainage ditches will not compensate, in terms of insect productivity, for the free-flowing streams that currently exist. During stream studies for the draft EIS on mountaintop mining, EPA sampled a sediment control ditch on a surface mine, and found it to be seriously degraded. Benthic invertebrate scores were in the "poor" or "very poor" range over five different sampling seasons, and dissolved oxygen concentrations fell to 3.6 mg/l (less than the required 5 mg/l) during one summer sampling event. While one example does not necessarily characterize all sediment control ditches, these are the kinds of sampling results that would be expected in such a setting unless good water quality, adequate substrate, adequate flow-through, and shading by trees are ensured.

Furthermore, a boulder-filled center drain in a valley fill will not replicate an ephemeral stream channel, with its associated aquatic life adapted to smaller substrates. Finally, it is unknown to what extent down-dip water sources, on-bench sediment ponds, and drainage ditches may be subject to selenium contamination. If selenium were present in these waterbodies, any insects inhabiting them could accumulate selenium to concentrations that may be harmful to bats (see "Foraging Habitat Degradation"*)*.

The BA does not indicate whether the applicant is proposing to provide compensatory mitigation for the probable impacts to water quality downstream of the valley fills. Based on the best available scientific information, impacts to downstream reaches would result in a loss or severe reduction in the Indiana bat prey base due to indirect stream impairment (further discussed in the "Indirect Stream Impairment*"* Section). Additionally, Indiana bats are known to forage in forested riparian habitat. Even if the mitigation streams provided a prey base, it is questionable whether the Indiana bat would actively forage in this open habitat. The presence of forested commuting corridors appears to be an important feature in determining whether an area is suitable to support Indiana bats, and Indiana bats appear to avoid traveling through open expanses of land (Murray and Kurta 2004; Sparks et at., in press). Mitigation stream corridors would most likely not provide intact forested riparian corridors for many decades after construction was completed (see "Reforestation" section). In order to be considered a beneficial impact to the Indiana bat that would mitigate the loss of foraging habitat, the Service would need to be reasonably certain that mitigation areas would not only provide a prey base for the Indiana bat, but the Indiana bat would utilize this habitat. In summary, the proposed compensatory mitigation is not likely to offset the effects of direct stream loss and reductions in the downstream prey availability and foraging habitat for the Indiana bat.

Installation of bat boxes and watering sources
The applicant has proposed this conservation measure as part of their mine reclamation plan. Evidence of Indiana bats using constructed bat boxes is extremely limited, with only three cases of documented use by adult females. In these cases, boxes were installed in forested habitat near natural water sources where natural known roost trees or foraging areas were present. Indiana bat use of these structures was not noted for many years after installation (Carter 2002; Indianapolis Airport Authority 2004; Butchkoski and Hassinger 2002; Kurta in press).

At the Six Points Interchange project in Indiana, approximately 3000 different artificial structures of various designs were installed to mitigate for the loss of potential roost trees. The bats took between 9-10 years to begin using the bat boxes, and most of the structures were never used (John Whitaker, personal communication). Monitoring and maintaining these structures for five years, as the applicant proposes, would probably not be sufficient time to allow a maternity colony to find these structures and begin using them, or to determine whether the structures were ever used. Carter (2002) noted that bat houses are not a substitute for natural roosting habitat, but that they may be a useful management tool in limited situations. Kentucky Indiana bat guidelines (KDSMRE et al. 2000) recommend that bat houses be used only in addition to other methods of preserving or creating roost trees. Therefore, installation of bat boxes may provide supplemental habitat for roosting only when placed within or near other existing trees suitable for roosting/maternity activity, and may be used to augment habitat when lack of roosting trees is a limiting feature, such as around the western maternity colony. However, the limited scope of this measure will not significantly off-set the large scale impacts of the proposed projects.

Indiana bats have been seen drinking, and to a lesser extent foraging around impounded water sources such as the watering holes proposed by the applicant (Gardner et al. 1991(a)). Created watering holes will not have the same biological inputs or ecology as natural stream courses and are not expected to provide a similar a prey base. However, they may provide additional drinking water for within the permit area. The Kentucky Guidelines (KDSMRE et al. 2000) recommend that one of these features be placed every for every 50 acres of permit area (the applicant proposed one every 250 acres), and that all watering areas be placed immediately adjacent to existing trees. Bats would not be expected to use these areas unless adequate surrounding cover was provided. It is not clear whether constructed watering areas would continue to hold water after construction, whether they would retain water during summer periods when water sources are most critical, or what the water quality of these areas would be. Without monitoring and maintenance, these features may not provide the anticipated benefits. Based on the proposed rate of construction, approximately 9 waterholes would be constructed. This would result in 0.019 acres of water being provided throughout the project area. This limited measure would not off-set the direct loss of over 4.4 acres of streams, and the indirect effects of downstream water quality degradation. Additionally, since these features would not be constructed until after the areas had been reclaimed, benefits of the measure would not be realized for many years. Therefore, if the proposed features are monitored and maintained they may be expected to provide some limited supplemental source of drinking water on-site, but will not significantly off-set the large scale impacts of the proposed projects.

In summary, the installation of bat boxes and watering sources is expected to have a minimal beneficial impact. This conclusion is based on the very limited scope of box placement and the uncertainty that Indiana bats will ever discover these supplemental roosts. With regard to the watering sources, it is not clear whether the watering areas would continue to hold water and provide a drinking and foraging source during summer periods when this type of habitat is most critical. Additionally, without any monitoring or maintenance, the Service is concerned about the long-term water quality of these areas and that these post-mined open areas will not be utilized by the Indiana bat after project completion.

Summer habitat retention

The applicant proposes to leave summer habitat on the lower slopes for both the mountaintop removal and contour mine projects, and on the upper slopes for the contour mine projects. The location of these remaining habitat areas and their potential suitability to the Indiana bat is described in the "Project Impacts to Forested Habitat" section. Remaining summer habitat will be degraded as a result of fragmentation, adjacent mining, and reduced water quality. It is likely that many of the areas that the applicant proposed to leave intact will not be suitable to support Indiana bats, or will have a reduced carrying capacity as a result of degradation. This conservation measure also does not serve to retain aquatic foraging such as headwater or intermittent streams, a habitat type that has been shown to be of biological importance to the Indiana bat. As currently proposed, a sufficient amount of habitat may not remain within the action area to support Indiana bat maternity activity. In addition, no assurances that this habitat will remain forested have been provided. Although the applicant currently has the mineral rights for these and other surrounding areas under lease, they have made no commitment not to mine these remaining lands. Also, without additional protections, surface land owners may also attempt to timber or otherwise develop these lands in a manner that would further reduce their suitability to support Indiana bats. Further, this measure is not truly a conservation measure because the project has not been modified to minimize impacts to summer habitat. The BA notes that "all potential Indiana bat habitat with the (permit) area will be removed."

Effects of Conservation Measures - Summary
The applicant proposed the following actions as conservation measures: 1) seasonal tree cutting restrictions; 2) post-mining reforestation; 3) post-mining stream restoration; and 4) installation of bat boxes and watering sources on reclaimed mine lands; and 5) leaving summer habitat intact. The conservation measures, as proposed would offer little to offset the effects of the project because: 1) it would be decades before sufficient tree cover is established to serve as foraging habitat, although even then, the quality of the foraging habitat is likely to be less than pre-project habitat due to loss of streams and tree species diversity; 2) post-mining stream restoration would not restore lost Indiana bat foraging habitat; 3) leaving a limited amount of forested habitat will not provide sufficient remaining foraging and roosting habitat to support Indiana bat maternity activity and will not offset the landscape level removal of forested habitat; and 4) the limited scope of installation of bat boxes and watering sources will not significantly off-set the large scale impacts of the proposed projects. In summary, other than the seasonal tree cutting restrictions, the conservation measures are not expected to substantially minimize or offset project related adverse effects to the Indiana bat.

Effects of the Action Summary
The proposed action will result in significant change in the summer environment for the maternity activity in the action area. The proposed action will remove approximately 2200 acres of habitat and will directly impact 11.95 miles of streams. When considered in addition to the baseline conditions, this will result in 78 percent of the terrestrial habitat within the action area becoming unsuitable for Indiana bats. The remaining forested habitat will be degraded due disturbance from adjacent mining, and fragmentation, making these areas increasingly less suitable to support Indiana bats as mining progresses. After completion of the projects, 75 percent of the streams within the action area will be directly impacted by mining. Because insects associated with aquatic habitats make up part of the diet of Indiana bats, loss and degradation of these habitats can also adversely affect the prey base of the species. Remaining streams will be degraded from the indirect effects of mining further reducing the availability of prey for the Indiana bat.

The proposed project will result in landscape level reductions in preferred foraging and roosting areas for Indiana bats, and will remove all the Indiana bat roost trees that have been identified. Significant portions or all of an Indiana bat's foraging/home range could be removed in a single year. Displaced Indiana bats will be forced to locate new roosts in the spring when they are stressed from hibernation, migration, and the increased energy costs of reproduction. Bats either remaining in the action area, or displaced from previously used foraging sites can be expected to have higher rates of reproductive failure, and may suffer from reduced foraging success, starvation, increased predation, and other stress-related mortality. Similar impacts have been documented for other species with similar life histories when they were faced with disruptions to breeding habitats.

Indiana bats currently using the action area will also face increased intra and interspecific competition as bats are displaced from disturbed areas leading to decreased survival and reproductive success, ultimately reducing colony size. As colony size decreases, the thermoregulatory and communal benefits experienced by the remaining bats will be decreased. There may be a loss of these communal benefits below a threshold colony size. It is unknown whether there is a minimum number of bats that are needed for a colony to be viable. Large scale habitat disturbances could disrupt Indiana bat colony dynamics and social bonds leading to the loss or repeated and increasing fragmentation, and eventual loss of a colony. The maternity colony within the action area is anticipated to have an insufficient population to withstand reduced reproduction and increased mortality over an extended duration. Since there is substantial information describing impacts to other species with similar behavioral characteristics in response to habitat loss, and some limited information regarding Indiana bat responses, it is reasonable to infer that significant impacts would be expected to occur to Indiana bat maternity activity. As stated above, however, in the absence of definitive answers to these questions, the Service has relied on the opinions of various Indiana bat experts to shape its effects determinations. Some experts believe that mitigating factors such as the mobility of the species and availability of additional habitat within the migratory abilities of this species will negate much of the potential impacts to the colony, and these factors will allow the colony to relocate with only minimal harm to individuals and little disruption to the maternity colony. Due to the lack of species-specific information and resulting uncertainty regarding the fate of a maternity colony when faced with large scale maternity habitat alterations, the Service held a meeting with a number of Indiana bat researchers. Many researchers suggested that the ability of a colony to adapt would depend on whether there was a sufficient amount suitable habitat in adjacent areas for the bats to move into. Ultimately, however, based on the best available information, including site specific information for this project, the Service determined that while it is possible that some remnants of the maternity colony may persist on the fringes of the site, or in adjacent lands, there is a reasonable certainty that impacts to individuals will cause continuing declines within the maternity colony leading to extirpation of that colony.

In order to determine the potential foraging and roosting area available to the colony, we evaluated a two-mile radius around each roost area. After project completion, 23 percent (1844 acres) of the area within the two-mile radius of the western roost area will remain as forested habitat and 75 percent of the stream miles will be directly affected by mining. When compared to available Indiana bat suitability indexes, it is likely that remaining forest cover will be inadequate to support the individuals at the western roost area. Indiana bats would be unlikely to be able to adapt to the currently proposed loss of habitat within the western roost area. These bats would be fully displaced from the majority of their home range over the life of the project. Loss of these individuals will contribute to extirpatation of the colony through loss of numbers and increased fission reactions when faced with loss of many roost trees, decreased habitat availability, successively reduced prey base, increased degradation of remaining foraging habitat, and increased intra and interspecific competition. After project completion, 55 percent (4436 acres) of the eastern roost area will remain as forested habitat, and 44 percent of the stream miles in the range of this portion of the colony will be directly affected by mining. A large block of contiguous forested habitat would remain to the northeast of the Laxare East project. The individual bats whose focal point was located in this area would be displaced from at least part of their home range, however sufficient forested habitat may exist in adjacent areas to allow some of these bats to adjust and expand their home range into new areas. Even under this scenario, however, the colony would still experience decreased survival, reproduction and fitness of its members, and while remnants of the colony might be able to relocate and survive, the long-term prediction for the colony is extirpation. With the exception of the seasonal tree cutting restrictions, the conservation measures are not expected to substantially offset project related adverse effects to the Indiana bat.

Other large mining projects adjacent to the action area restrict the availability of forested habitat to displaced bats. One large block of contiguous forest remains to the northeast of the action area. This is most likely the area that Indiana bats would attempt to colonize if they attempted to remain in the area after displacement from portions of their home range within the action area. It is unknown whether this area has the characteristics necessary to support viable maternity activity. It is possible that this adjacent area is already occupied by other colonies of Indiana bats, and that these colonies would be impacted by displaced Indiana bats moving into their established home ranges. However, no conclusions can be made about this potential without additional survey data. Preservation of significant amounts of forested and aquatic habitat within the action area, or in remaining adjacent habitats, and an undemonstrated ability to quickly adapt and relocate in response to landscape level habitat destruction appear to be crucial to the continued survival of the Indiana bat maternity colony. None of these conditions are anticipated.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act.

Reasonably Foreseeable Projects

We are aware of three additional projects for which State mining permits have been sought, or will be sought in the near future. All of these projects occur either partially or wholly within the action area considered in this biological opinion. As discussed below, there is either no clear Federal nexus for these projects (i.e., no Federal permit or authorization required), or no clear indication that tree clearing associated with these projects will undergo consultation; therefore, for the purposes of this analysis, we are considering these to be non-Federal actions that are likely to occur in the action area in the near future.

The two projects that are the subject of this biological opinion, and any additional mining projects proposed in the action area, require a State-issued Surface Mining Control and Reclamation Act (SMCRA) permit. Because the U.S. Office of Surface Mining (OSM) has delegated SMCRA authorities to the State, including the issuance of mining permits, no Federally-issued mining permit is required.

The delegation of SMCRA implementation to the States was the subject of a national programmatic formal consultation between OSM and the Service in 1996. This consultation concluded with the issuance of the *Formal Section 7 Biological Opinion and Conference Report on Surface Coal Mining and Reclamation Operations Under the Surface Mining Control and Reclamation Act* (dated September 24, 1996) to OSM. In this opinion, it was determined that administration of SMCRA (including the issuance of SMCRA permits) by the States was not likely to jeopardize the continued existence of any federally listed species, or any species that would be listed in the future. Although this programmatic biological opinion did not analyze the potential effects of SMCRA implementation on particular species, or estimate levels of take for any of these species, it assumed that such take would be minimized by project-level coordination between the Service and the States. Recognizing that in many cases OSM had already delegated its SMCRA authorities to the States, and recognizing that State-issued SMCRA permits are not in and of themselves Federal actions, the programmatic biological opinion did not provide for project-specific (or “tier 2”) section 7 consultations.

Mining projects similar to the projects in question should also be subject to section 7 consultation with the Corps if “jurisdictional” wetlands will be affected. Such was the case in this consultation with the Corps. Based on past permitting practices (i.e., the routine issuance of Nationwide Permit #21 for valley fills), it is evident that the vast majority of future projects of this nature will require Clean Water Act section 404 authorization for the project-related valley fills. In cases where a federally listed species occurs in the project action area, consultation should occur. However, in some cases the Corps has not considered the effects of actions related to wetland encroachments, particularly when those effects will occur entirely or primarily in uplands over which the Corps has no jurisdiction. Therefore, while it is clear that future projects that result in wetland or stream encroachments will require section 404 authorization, it is not clear whether the effects of such projects will undergo consultation with the Service, particularly in cases where an upland species like the Indiana bat is involved.

Our uncertainty regarding the presence of a Federal nexus for future surface mining is based, in part, on the Corps’ letter of March 25, 2004 (U.S. Department of the Army 2004). In that letter, the Corps has explicitly stated that, “(t)he Corps does not have sufficient control and responsibility over the upland timber removal activities. Further, these proposed timber removal activities are not jurisdictional regulated activities pursuant to section 404 of the Clean Water Act, could stand alone, and are not dependent upon the Corps authorization of the proposed activities (i.e., construction of valley fills and sediment ponds) within jurisdictional waters of the U.S. The Corps does not have enforcement authority over a non-jurisdictional activity.” As described in the “Roosting Habitat Loss” section, tree removal is one of the activities expected to result in the injury or death of the Indiana bat. Since, according to their letter, tree removal could occur within these additional mining areas absent section 7 consultation with the Corps, we are proceeding with the assumption that the effects of such projects may not be considered in the context of a section 7 consultation between these agencies.

Due to the uncertainty that future projects of this nature will undergo consultation with the Corps, or undergo coordination with the State, the projects described below are being described under the category of cumulative effects. Their consideration in this section of the biological opinion does not authorize any incidental take that would result from these projects if they were constructed. Also, discussion of these projects does not preclude future consultation on these projects, should it be determined that they will require Federal authorization, and should the Federal action agency choose to consult with the Service.

The Service is aware of three additional mining projects that have been proposed by the Elk Run Coal Company. These permits are the Checkmate Amendment, Black Castle Contour Amendment #1, and Short Ridge. All of these projects occur either wholly or partially within the action area, and are within a two-mile radius of one or both of the two maternity sites. Elk Run Coal Company has applied for a State SMCRA permit for the Checkmate Amendment and the Black Castle Contour Amendment # 1. These applications are currently pending with the West Virginia Department of Environmental Protection. In a July 2003**,** letter to the Service, the applicant's consultant indicated that a SMCRA permit application for the Short Ridge project would be submitted within a couple of months. Considering the timing of these permit applications, it is likely that these projects overlap the same time frame as the Laxare East and Black Castle Contour mining projects. The Service has not received detailed project descriptions for these potential permits, and in many cases the Service has been provided with varying estimates of the projects' size. The Service is using the most recently received size estimates for the purposes of this analysis.

The Checkmate Amendment will affect approximately 20 acres immediately adjacent to the proposed Black Castle Contour mine. This project will have no wetland or stream impacts, and therefore will not require section 404 authorization from the Corps. This project will serve to connect the Black Castle Contour mining area with the Checkmate mine, in order to facilitate the movement of equipment and materials. Although this project will remove potential roosting and foraging habitat, the effects to bats are not anticipated to be as great as those expected for the Laxare East or Black Castle Contour projects due to the small acreage involved.

The Black Castle Contour Amendment # 1 will affect 226 acres in the contour immediately above the Black Castle Contour mine. This project will require section 404 authorization because the applicant has proposed to extend valley fills associated with the Black Castle Contour mine. No information has been provided regarding the amount or location of forested habitat affected by this permit, however it is anticipated that this permit would have additional impacts to foraging and roosting habitat of the bats.

The Short Ridge project will affect 648 acres of habitat in the headwaters of Sandlick Creek, and will extend valley fill 11 of the Laxare East project further downstream. This project area is located in between the Black Castle Contour and Laxare East project areas, is immediately adjacent to the identified roost trees for Indiana bat #3351, and includes the capture site for that bat. Construction of this project would remove some of the habitat that would remain in the action area after construction of the two proposed actions. Habitat that would be removed includes 280 acres of forested habitat between the headwater tributaries of Sandlick Creek and Mudlick Fork, and a portion of the 370 acres of forested habitat along Sandlick Creek. Loss of this habitat will increase the already-significant habitat loss that will be experienced by the Indiana bats in the western roost area (as discussed above), and further increase the anticipated degradation of the Sandlick Creek watershed. Construction of this project would exacerbate the impacts to Indiana bats within the action area.

Any additional mining within the action area is expected to have similar impacts as those anticipated as a result of the proposed action, however additional mining would also compound the severity and duration of these effects. These impacts further increase the likelihood that that insufficient forested and aquatic habitat will be available to support Indiana bat maternity activity, and that any colony present within the action area will be so severely impacted that it becomes no longer viable.

In addition to the three additional mining projects within the action area that have been already been proposed, the applicant involved in this consultation currently has over 12,000 acres of land within and around the action area under long-term lease. The lease on these currently unmined properties is the same as for the properties currently proposed to be mined (Alan Ashley, personal communication, Massey Energy Company). Considering the location of this property, the mining company's interests in the property, and the degree of past and present mining in this area, it is reasonably foreseeable that mining could occur here. This acreage includes over 6,000 acres of largely contiguous forest located immediately northeast of the Laxare East project area. As described in the "Two-Mile Radius Analysis" section, other mining projects are already underway in adjacent habitats to the west, southwest, and south of the action area. It is therefore, the area to the northeast that bats are most likely to move into when they are displaced from the Laxare East and Black Castle Contour project areas. This is the same acreage as is already under lease by the applicant. While we have no information on the quality of this area in regard to its ability to support Indiana bats, aerial photography indicates that habitat in these areas appear similar to that found in the Laxare East permit area. Loss of several hundred acres of this forested habitat would significantly reduce the availability of the only remaining adjacent forested habitat.

According to information provided by the applicant, there are also several parcels of land surrounding the action area that are currently leased or controlled by other mining companies. These areas are listed as "adverse surface" lands on maps produced by the applicant (Black Castle Mining Company 2003). These lands are located along Laurel Creek to the east of the proposed action; to the north along Drawdy Creek; and to the northwest and west of the proposed action. While no exact acreage figures are available for these areas, it appears that at least 2000 acres would fall into this category of land. These lands could also be subject to future mining. Should mining be conducted here, it would further restrict the availability of adjacent forested habitat that could support the Indiana bat.

Post-mining Land Use

The State requires reclamation of mined lands, at a minimum, to meet the standards under the Surface Mining Control and Reclamation Act (SMCRA). Coal companies must post bonds that will be held by the State until post-mining reclamation is approved. Final bond release could occur within five years if the reclamation meets State standards. Since bond release could occur on sections of the mine permit before the total project is completed, portions of the projects could be released within the proposed life of the project. There are multiple private landowners that own the surface rights to the mined lands in the action area. After final bond release, the landowner may change the vegetation used to reclaim the site, develop the site, or otherwise alter the landscape on the site in any way he/she chooses as long as the discharge from the site meets State water quality standards. Considering the above, it is reasonably foreseeable that private landowners will undertake activities that will alter reclaimed vegetation. Such activities could include timber harvesting, grazing, or some other agricultural use. As a result, there are no assurances that any of the applicant's proposed conservation measures such as bat boxes or reforestation measures would be maintained on site for more than five years, or that any forested habitat remaining post-project would be maintained and managed to support the Indiana bat.

Summary of Cumulative Effects

Three additional mining projects, totaling at least 894 acres, have been proposed to occur within the action area. There are no assurances that tree clearing or other construction related impacts from these projects will be subject to future consultation with either the WVDEP or the Corps. Construction of these projects could further reduce the forested and aquatic habitat remaining within the action area to the point that insufficient habitat would remain to support viable maternity activity in the action area. Other mining projects are already underway in adjacent habitats to the west, southwest, and south of the action area. It is therefore, the area to the northeast of the action area that bats are most likely to move into when they are displaced from the Laxare East and Black Castle Contour project areas. However, habitat within this area is already under lease by either the current applicant or other mining companies. Construction of additional mining within this habitat would subject any Indiana bat maternity activity within the area to further adverse impacts and increase the potential that the maternity colony will be so severely affected that they would no longer be viable. Current bonding procedures for mining permits provide no assurances that any of the applicant's proposed conservation measures or any forested habitat remaining post-project will be maintained and managed to support the Indiana bat. Without further assurances that these areas will not be mined, and that sufficient forested habitat will remain either within the action area or in adjacent habitats, the Service can not conclude that a viable Indiana bat colony could be maintained in the area.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed mining projects, and the cumulative effects, it is the Service's biological opinion that the action, as proposed is not likely to jeopardize the continued existence of the Indiana bat. Critical habitat for this species has been designated at hibernacula in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia; however, this action does not affect these areas, and no destruction or adverse modification of critical habitat is anticipated.

Although recent census information shows a slight increase from 2000 to 2003/2004, the Indiana bat is a species in serious decline. Prior to European settlement, overall abundance of the Indiana bat numbered in the millions and may have rivaled the population numbers of the now extinct passenger pigeon. During the last 40 years, the range-wide population of the Indiana bat has declined 57 percent with population decreases of 23 percent from 1960/70 – 1980, 30 percent from 1980 – 1990, and 19 percent from 1990 – 2000. Despite significant recovery efforts through the 1990s to protect hibernacula, this decline has continued. While the cause of the continuing decline is unknown, several environmental threats are considered to be possible causes including pesticide contamination and summer habitat loss. The population projection described in the Status of the Species Section indicates the current estimated population will be reduced by 50 percent in the next 15 to 30 years if trends continue.

Indiana bats, like all animals that are long-lived and have low reproductive rates, are especially sensitive to anthropogenic disturbances and environmental change. These traits make bats vulnerable to population declines and severely limit their ability to respond quickly to perturbations. Indiana bats have well documented site fidelity to colonial maternity roosting sites. Colonial roosting is an adaptation required for proper thermoregulation during pregnancy and rearing pups. When female bats return to traditional maternity roost sites, they are physically stressed from 5-6 months without food during hibernation. They also have growing energy demands due to gestation of their pups. They may be additionally stressed from migration to their summer range. During this period, female bats have high nutritional requirements and need access to sufficient foraging habitat, water sources, and a colonial roost to minimize energy loss from the combination of increased metabolic processes and cool night time temperatures.

The proposed action will result in the long-term/permanent loss of nearly 2,200 acres of occupied Indiana bat maternity habitat over a period of 12 years. When the Indiana bats return to their traditional summer range, they will face landscape level changes to their habitat. The familiar aspects of the landscape used to migrate, navigate and gather at roosting sites will be eliminated. Thus, each year the required colonial roosting behavior will be disrupted, and the maternity colony will become further fragmented and displaced. Consequently, individuals will be forced year-after-year to shift and expand their roosting and foraging ranges and compete with other species for food and roost sites with hundreds of other displaced bats, as well as be at a competitive disadvantage with resident bats whose ranges they will enter. All this occurs at a time when females arrive with an already large nutritional deficit from hibernation, migration and growing nutritional needs from pregnancy. While female Indiana bats have evolved to move over the landscape in response to the ephemeral nature of maternity roosts, the coordinated relocation of a maternity colony is only known to occur in a slow, methodical manner, into familiar habitat. Although some Indiana bat experts believe these bats would experience little difficulty adapting to landscape level changes, there is little evidence to suggest that the bats are able to adapt to sudden and extensive losses of these familiar maternity sites, roosts and habitat, as will occur in this project and the Service has determined that, based on the best available information, it is likely that this level of impacts will result in extirpation of the colony.

Although the capture of reproductive females has been the primary/exclusive means for locating maternity colonies throughout its range, the capture of 3 reproductive bats on site have not lead to the identification of primary roost trees or a maternity colony of the expected size. While exhaustive on-site surveys done in cooperation with the Service have not been completed, past impacts in and adjacent to the action area, suggest that the maternity activity has already experienced substantial impacts and fragmentation. The Service believes that these conditions make it likely that the type of impacts described in the “Effects of the Action” section, have already begun from past activities, and the colony is experiencing fragmentation and the anticipated declines in colony size. So, while this project is likely to cause significant impacts to the remaining Indiana bats, the effects will only exacerbate, rather than create, a decline that may have been set in motion by habitat loss and degradation caused by previous logging and mining activities. Therefore, while the extirpation of the colony is more likely due to the proposed project, the significance of the impacts of this particular project to the Indian bat is somewhat less in terms of the jeopardy determination, than if the project were occurring in pristine habitat with a healthy, viable maternity colony.

Jeopardize the continued existence of a species means to engage in an action that reasonably would be expected, directly, or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

While the Service anticipates extirpation of this colony, the past impacts, current site conditions and probable declining status of this colony and small colony size, means that the effects of this project would not cause species-level impacts. Therefore, in conclusion, after evaluating the current status of the species, the environmental baseline for the action area, the effects of the proposed mining projects, and the cumulative effects, it is the Service’s biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Indiana bat by engaging in an action that reasonably would be expected, directly, or indirectly, to reduce appreciably the likelihood of both survival and recovery of the Indiana bat in the wild by reducing reproduction and distribution of the species in the wild.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without any exception. “Harm” in the definition of “take” in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” in the definition of take means an intentional or negligent act or omission which creates the likelihood of injury to wildlife annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of the incidental take statement.

Because incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity, this Incidental Take Statement is valid only upon receipt by the applicant of all appropriate authorizations and permits from Federal, State and local permitting authorities. These permits/authorizations may include, but are not necessarily limited to, a Clean Water Act (section 404) permit from the Corps of Engineers; a National Pollutant Discharge Elimination (NPDES) permit, section 401 Water Quality Certification, and an Article III mining permit from the West Virginia Department of Environmental Protection. It is incumbent upon the Service to make it clear to the Corps and the applicant that this incidental take statement (along with its exemption from the section 9 prohibitions of the Endangered Species Act) is valid only upon receipt of all required permits and authorizations.

This incidental take statement only addresses incidental take resulting from the Black Castle Contour and Laxare East projects as described in BA, and does not permit any incidental take resulting from adjacent projects, past projects, future projects, or cumulative effects. In addition, this opinion does not extend incidental take coverage to either the Office of Surface Mining or the West Virginia Department of Environmental Protection, unless the Article III mining permits for these projects are conditioned to include the Reasonable and Prudent Measures and Terms and Conditions contained in this opinion.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any funding, permits, and/or approvals, as appropriate, issued to the applicant for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps 1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit; and/or 2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Based on our analysis of the environmental baseline and effects of the proposed action, at least one Indiana bat maternity colony occupies the action area and will be impacted as a result of the proposed projects. As discussed in the "Environmental Baseline" section of this opinion, this colony may consist of between 4 and 40 Indiana bats. Due to the adverse effects that recent mining and timbering operations have had on the quality, quantity and distribution of potential roosting and foraging habitat, this colony may be smaller and less cohesive than colonies studied elsewhere in the species' range. A reduction in colony size has likely already occurred directly through the previous felling of occupied roost trees, as well as through "harm" and "harassment" resulting from habitat loss, degradation and fragmentation from past projects. The proposed projects are anticipated to further affect this colony, as detailed under "Effects of the Action".

Implementation of the Laxare East and Black Castle Contour projects is expected to result in the permanent loss of approximately 2199 acres of suitable summer foraging and roosting habitat for

Indiana bats, as well as 11.95 miles of stream habitat. In addition, these projects are expected to result in the fragmentation and degradation of an additional 917 acres of forested habitat, reducing or precluding use of these areas for foraging or roosting. An undetermined number of stream miles within the action area (but outside the project footprint) will be degraded by mining due to the presence of valley fills. Forest and aquatic invertebrates, the prey sources for Indiana bats, will be affected by forest and stream loss and degradation, resulting in a reduction in the quality, quantity, and seasonal availability of food for Indiana bats.

The Service anticipates that take in the form of killing, harm and harassment (as defined in 50 CFR §17.3) will occur as a result of the direct and indirect effects of the proposed mining action~~.~~ and that all individuals present within the action area will be subjected to some form of take through lost reproductive capacity, predation, or reduced fitness leading to injury or death. While it is anticipated that all individuals in the colony will be "harmed" or "harassed" to some extent, harm may be manifested in sub-lethal injury in the form of lost reproductive capacity, or reduced fitness that may lead to more serious injury, or death for all or some members of the colony. Forest clearing associated with these projects will destroy all of the known roost trees and roosting areas for the colony. In addition, much of the foraging habitat that is likely to be currently supporting the colony will be eliminated, fragmented or degraded. Collectively, the loss, degradation and fragmentation of foraging and roosting habitat is expected to result in the death of some bats (fetal, juvenile and adults) and injuries in the form of a reduction in the reproductive output of others, as a result of increased metabolic expenditures, decreased food supply, increased exposure to predation, increased competition, and decreased colony cohesiveness.

Stress, reproductive impairment, and mortality due to reductions in the quantity and quality of foraging and roosting habitat are predicted to occur in the 2199-acre project footprint, as well as adjacent forested and aquatic habitats directly and indirectly affected by mining. Behavioral and physiological responses of Indiana bats to habitat loss will likely result in some bats being in poorer body condition (*e.g.*, having less stored fat) during migration and hibernation. Therefore, increased Indiana bat mortality is also expected at hibernacula, and along spring and fall migration routes.

The death of individuals, decreased fitness of individuals, reduced reproductive potential, and reduced over-winter survival of all individuals within the colony is likely to occur. This will reduce the size and reproductive potential of the maternity colony over the12 year life of the project, and this decline, accompanied by habitat alteration. A long-term decline in the size of and viability of the colony present within the action area is expected, with bats within the western colony area being affected to a greater degree than the eastern colony.

Due to the nature of the project, and the historical lack of success in reclaiming diverse, high-quality forest and stream habitats on mined lands, Indiana bats will not re-colonize the 2199-acre project footprint. In addition, degradation and fragmentation of forested and aquatic habitats adjacent to the project footprint will limit or preclude Indiana bat use of these areas. As discussed in the "Cumulative Effects" section of this opinion, additional forested habitat in and around the action area is expected to be lost due to future mining.

Mortality or decreased reproductive output can be expected for any colony member that is unable to: locate suitable roosting and foraging habitat elsewhere, as currently occupied roosting and foraging habitat is cleared; find new, suitable roost trees; find a sufficient prey base within new foraging areas; find and congregate with other colony members; compete with resident and displaced bats within new foraging habitat; and build up sufficient fat reserves, in light of these increased energy demands. Those individuals who fail to locate other colony members and establish themselves in suitable roosting and foraging habitat outside the project footprint will likely perish. The effects of increased mortality and decreased reproduction at the individual level will be reflected at the colony level, as discussed below.

It would be extremely difficult to quantify the level of take from each aspect of these projects, especially to individual bats. However, the basic measure of reproductive activity for this species is the maternity colony as a discrete reproductive unit, and the level of take is most easily considered at that scale. The extent of impacts to a colony will depend on the location and distribution of that colony's roosting and foraging habitat within the action area. If the colony's roosting and foraging areas are concentrated in the western part of the Laxare project area risks the complete loss of these areas. That portion of the colony may experience a significant reduction in the number of individuals using that habitat. However, the colony members whose roosting and foraging areas are concentrated near the eastern edge of the Laxare project area may have a greater chance of successfully shifting and persisting during the short term, due to the presence of potentially suitable forested habitat to the east of Laxare. Ultimately, however, the colony would still experience a significant reduction in size, decreased colony cohesion, and is likely to become extirpated.

Although we expect all members of the colony will be harmed or harassed, as discussed above, the actual level of incidental take will be difficult to detect or quantify because individuals are small, evasive, and rather cryptic, making them difficult to locate and track. Therefore, it is unlikely that dead or moribund bats will be found, even though we expect individuals will die as a result of the proposed actions. Due to our inability to fully quantify take using only one measure, the Service has included take estimates at the individual and colony level, as well as indirect measures of take at the summer habitat level, in Table 16 to further clarify and encompass all levels of take of the Indiana bat. The *Reasonable and Prudent Measures* and their implementing *Terms and Conditions* provide for monitoring to more clearly establish the pre-project baseline, to document take, and to determine whether the effects of the project on Indiana bats and their habitat are consistent with those anticipated in this opinion.

Table 16. Indiana bat incidental take estimates for the Laxare East and Black Castle Contour Projects

Take Unit	Amount of Take	Type of Take (or Effect)	Area Within Which Take (or effect) is Anticipated to Occur
Individual	No more than 40 adult females and their pups	Harm due to habitat loss, degradation and fragmentation – resulting in increased mortality and injury, and decreased reproductive output during the12 years of mining	Action area, hibernacula, and migration routes
	No more than 40 adult females and their pups	Harassment during active mining (*e.g.*, due to blasting, use of heavy equipment, competition)	Action area
Colony[1]	Up to 100%	Harm due to habitat loss, degradation and fragmentation. Up to a 100% reduction in the size of the colony present within the action area, is anticipated during the 12 years of mining.	Action area, hibernacula, and migration routes; may extend into foraging and roosting habitat outside the action area if/when bats move
	Entire	Harassment during active mining (*e.g.*, due to blasting, use of heavy equipment)	Action area
Forested Habitat[2]	2199 acres	Permanent loss of foraging and roosting habitat, including all known roost trees and roosting areas	2199-acre project footprint
	917 acres	Habitat fragmentation and degradation, resulting in loss of potential foraging and roosting habitat	Action area
Stream Habitat[2]	11.95 miles	Permanent loss of streams and their associated watering and prey base for Indiana bats	2199-acre project footprint
	All streams within action area	Long-term alteration of streams and their associated watering and prey base for Indiana bats	Action area

[1] One colony with no more than 40 adult females and their pups, and with no less than four adult female bats total.
[2] Indirect measure of incidental take

If any of the incidental take levels in Table 16 are exceeded, such incidental take represents new information requiring review of the reasonable and prudent measures provided, and may require reinitiation of formal consultation. Incidental take will be tracked by monitoring the size, membership, distribution and location of the maternity colony (see “Terms and Conditions”). If a colony with more than the anticipated number of individuals is located, or it is determined that more than one colony exists on site, this represents new information requiring a review of the reasonable and prudent measures, and may require reinitiation of formal consultation.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the Indiana bat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of Indiana bats.   In order to be exempt from prohibitions of Section 9 of the Act, the Corps and the applicant must comply with the following terms and conditions which implement the reasonable and prudent measures and outline reporting/monitoring requirements. These terms and conditions are non-discretionary. Each RPM is listed in italics, followed by numbered terms and conditions that implement each RPM. The term “reasonable measures” as used below is defined as measures to minimize take that do not alter the basic project design, location, scope, duration, or timing of the project and involve only minor changes.

RPM 1: Avoid direct take by conducting all timber harvesting and tree cutting activities when Indiana bats are unlikely to be present.

Cutting trees while bats are present may cause death and injury to adult Indiana bats and their young, and may also disrupt roosting and maternity behavior.   The potential for direct take will be avoided by conducting all tree clearing activities during the hibernation period for the Indiana bat (November 15 to March 31) when Indiana bats are either hibernating or congregating around the hibernacula.

<u>RPM 1: Terms and Conditions</u>:

1.1 The applicant shall conduct all timber harvesting and tree cutting in the permit area between November 15 to March 31, when Indiana bats are unlikely to be present within the permit area.

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RPM 2: Conduct a comprehensive survey within and adjacent to the permit area using a variety of techniques to identify areas of concentrated Indiana bat usage; conduct an assessment to identify priority suitable habitat within the permit area that are not proposed to be cleared and areas adjacent to the permit area; and implement reasonable measures to conserve these priority suitable habitats.

To establish baseline conditions and ensure compliance with the established level of take, comprehensive surveys within the permit area are necessary. As described in the "Analysis of Adjacent Habitat" section, Indiana bats present within the permit area will most likely be displaced into adjacent habitats. The large block of contiguous forest located to the northeast of the permit area that is currently under lease entirely by the applicant and that does not appear to be bisected by any other adverse surface leases is the area that displaced Indiana bats are most likely to attempt to colonize. The Service is not aware of any surveys that have been conducted for Indiana bats within this area. It is possible that this area is already occupied by other colonies of Indiana bats, and that these colonies would be impacted by displaced Indiana bats moving into their established home ranges. To establish baseline conditions and ensure compliance with the established level of take, it is necessary to conduct comprehensive surveys within these adjacent habitats in addition to the permit area.

Project impacts to Indiana bats could be minimized by protecting priority suitable habitat in areas Indiana bats currently and may continue to use and areas to which Indiana bats may be displaced as a result of the project. Identification of these priority suitable habitat areas will guide the identification of reasonable measures to conserve these areas.

<u>RPM 2: Terms and Conditions</u>:

2.1 The applicant shall comprehensively survey forested and aquatic habitats within and adjacent to the permit area to determine baseline conditions for the Indiana bat. Surveys adequate to detect the presence of Indiana bats; identify currently used roosting and foraging areas; estimate the number and size of maternity colonies; and establish the size of Indiana bat home ranges shall be conducted as defined under RPM 5 during the first maternity season. These surveys should include areas currently under lease by the applicant that are located to the north/northeast of the permit area. The applicant and/or their consultants shall make reasonable efforts to obtain permission to conduct surveys on any adjacent or nearby lands that Indiana bats within the permit area may also be using. Surveys within these additional areas shall comply with the terms and conditions established for surveys within the permit area (RPM 5) with the exception that monitoring of adjacent areas need not be conducted in subsequent years unless data indicate that Indiana bats may be utilizing these areas.

2.2 All Indiana bat monitoring efforts shall be supervised by a qualified surveyor with experience identifying and working with Indiana bats. At the time work is conducted, lead surveyors on-site must hold any permits required by the Service and have a valid collecting permit from the WVDNR.

2.3 The applicant shall coordinate all surveys with the Service prior to conducting the work. Proposed survey locations, frequency, level of effort, and methods for each field season shall be submitted to the Service for review and concurrence at least 45 days prior to the beginning of each monitoring season.

2.4 Within one year of permit issuance, the applicant shall conduct qualitative and quantitative roosting and foraging habitat assessments in areas accessible to the applicant by right or by permission to determine whether habitats that will remain in the permit area and habitats adjacent to the permit area are suitable to support Indiana bats and to identify areas that would be most suitable to support Indiana bat maternity activity. These assessments shall focus on, but not be limited to, habitats located along the riparian areas of Sandlick Creek and its tributaries, and existing forested habitat located to the north/northeast of the Laxare East permit. This assessment may use existing Habitat Suitability Indexes or other methods, as appropriate. The applicant shall submit an assessment plan to the Service and the Corps for concurrence at least 45 days prior to the initiation of the work.

2.5 Within two years of permit issuance, the applicant shall identify priority conservation areas based on the results of RPM 2.1 and RPM 2.4 above. These areas shall be selected based on demonstrated Indiana bat usage or on their ability to provide: 1) large forest blocks; 2) migration corridors and connectivity among existing stream corridors and blocks of forested habitat; 3) intact ephemeral, intermittent, and perennial stream courses with forested riparian buffers for foraging and travel; and 4) high quality roost and maternity trees. All information regarding the identified priority conservation areas shall be submitted to the Service for review and concurrence.

2.6 Within three years of permit issuance, the applicant shall implement reasonable measures to provide for long-term conservation of the priority conservation areas identified pursuant to RPM 2.5. Measures to achieve long-term conservation may include, but are not limited to, purchasing timber rights and establishing a management agreement, conservation easement, or other legal mechanism. The applicant shall provide to the Corps and the Service documentation that all available reasonable measures have been identified and implemented.

RPM 3: Implement reasonable measures to modify the placement of fill in waters of the United States to reduce impacts to known Indiana bat foraging and roosting areas.

The applicant indicated by electronic mail dated November 29, 2004, that they believe they have minimized fills to the maximum extent practicable based on engineering design constraints. However, the Corps is required to conduct a National Environmental Policy Act analysis and Clean Water Act 404(b)(1) analysis under regulations governing the issuance of individual Clean Water Act permits. That analysis may reveal additional reasonable measures that could be implemented to avoid and minimize impacts to foraging and roosting habitat.

<u>RPM 3: Terms and Conditions</u>:

3.1 In accordance with the National Environmental Policy Act and other regulations governing the issuance of individual permits under the Clean Water Act, the Corps must evaluate measures that may be available that would minimize fills in Waters of the United States, focusing on measures that would reduce impacts to the Sandlick Creek watershed and avoid or minimize impacts to known Indiana bat roosting and foraging areas, including those areas designated as Black Castle Contour fill 11 and Laxare East fills C and G. If that analysis indicates that reasonable measures are available that would reduce impacts to the Indiana bat, the Corps, in accordance with its authorities, shall require that these measures be implemented. The results of that analysis shall be coordinated with the Service to confirm reduction of impacts to Indiana bats. The applicant shall provide to the Corps and the Service documentation that all available reasonable measures have been identified and implemented.

RPM 4: Implement reasonable measures to delay impacts to foraging and roosting habitat within and/or adjacent to the permit area to minimize impacts to Indiana bats.

As described in the "Effects of the Action" section, the proposed project will severely limit the availability of suitable roost trees and foraging habitat. This will reduce the probability that Indiana bats returning to the area will be able to find enough habitat in close proximity to established maternity areas to overcome post-migration stress, have enough suitable habitat to support the colony, or find sufficient travel corridors to shift their foraging and maternity ranges to adjacent intact habitat and adjust to changing habitat conditions. Delaying impacts to foraging and roosting habitat within the permit area will reduce the potential for take from these effects and increase the possibility that the colony will persist.

RPM 4: Terms and Conditions:

4.1 The Corps and the applicant, in coordination with the Service, shall review the results of surveys conducted under RPMs 2 and 5, and the applicant shall use this information to identify and implement all reasonable measures to minimize impacts caused by displacing Indiana bats through modification of the timing and phasing of clearing and/or construction. These measures shall focus on delaying disturbances to known roosting and foraging areas, including disturbances resulting from Black Castle Contour's valley fill 11 (known foraging area of Indiana bats) and Laxare East's valley fills C and G (known roost area for Indiana bats), and designing construction to allow for travel corridors from existing roosting/foraging area into conservation areas as identified pursuant to RPM 2.5. The applicant shall provide to the Corps and the Service documentation that all available reasonable measures have been identified and implemented.

RPM 5: Monitor Indiana bats to identify areas on-site that are used by the bat and to quantify the amount and type of take.

It is anticipated, based on the analysis presented in this biological opinion, that foraging and roosting areas currently used by Indiana bats will be destroyed, degraded, and fragmented. Bats will be displaced from current foraging and roosting areas. These impacts will result in reduced survival, reproduction, and fitness of individual bats and reduce the overall size of the maternity colony. Monitoring studies have the potential to identify these effects. A plan for surveying, monitoring, and reporting on the Indiana bat within the permit area and adjacent habitat shall be developed and conducted in consultation with the Service.

The purpose of the monitoring plan is to: 1) ensure compliance with the established level of incidental take; 2) assess the effectiveness of RPMs and conservation measures over time; 3) determine the need for adjustments to management of the Indiana bat habitat; and 4) evaluate the response of bats to the disturbance that will occur in the permit area. The monitoring plan shall be designed to meet these minimum specifications and include mist-netting, acoustical surveys, telemetry, emergence counts, and reporting of results.

RPM 5: Terms and Conditions:

5.1 The applicant shall monitor Indiana bats annually over the life of this project beginning in the year that the permit is issued and continuing at least two years past the completion of all mining and reclamation within the permit area. Each year, monitoring shall be conducted during the maternity season of April 1 to November 15, and shall include mist netting, telemetry, and emergence counts during the sampling periods of Indiana bat pregnancy (May 15 – June 15); lactation (June 15- July 15); and post-lactation/juvenile volancy (July 15 – August 15). Survey elements shall be designed to meet the minimum qualifications as outlined below.

5.2 All Indiana bat monitoring efforts shall be supervised by a qualified surveyor with experience identifying and working with Indiana bats. At the time work is conducted, lead surveyors on-site must hold any permits required by the Service and have a valid collecting permit from the WVDNR.

5.3 The applicant shall coordinate all surveys with the Service prior to conducting the work. Proposed survey locations, frequency, level of effort, and methods for each field season shall be submitted to the Service for review and concurrence at least 45 days prior to the beginning of each monitoring season.

5.4 The applicant shall conduct mist-net and acoustical monitoring surveys annually throughout the permit area and adjacent areas that Indiana bats are likely to colonize or be displaced into. Surveys shall be sufficient to monitor previously identified foraging and roosting areas, and identify new roosting and foraging areas that may be used by displaced bats. Acoustical monitoring shall be used to screen and prioritize potential mist net locations, and/or monitor general bat activity at a location. Mist netting once annually during each sampling period (as defined in 5.1) need not exceed the level of effort as defined under the mist net survey protocols. Mist netting during each sampling period may be discontinued when the target number of bats are caught (as defined in 5.6). Mist net survey locations shall be designed to avoid the use of invasive techniques that may cause roost abandonment. Sampling locations may be adjusted each sampling period as original locations are impacted by construction or if previous monitoring suggests more productive sample locations. The applicant and/or their consultants shall make reasonable efforts to obtain permission to conduct surveys on any adjacent or nearby lands that Indiana bats within the permit area may also be using.

5.5 All Indiana bats captured shall be fitted with a numbered, lightweight band. The most current banding procedure or marking recommendations shall be followed. Wing punches and hair samples shall be gathered and retained for all Indiana bats captured. Hair and wing samples shall be retained, processed and analyzed according to the direction of the Service. Stable isotope analyses shall be conducted on hair samples unless otherwise directed by the Service. Other data collected on captured bats shall include species, age, sex, right forearm length, weight, and reproductive condition. Capture specifics such as vertical location in the net, flight direction, and time of capture shall also be recorded. All bats shall be released at the net site unharmed in compliance with procedures designated by the Indiana bat recovery team, or other Service protocols.

5.6 The applicant shall conduct telemetry studies annually during each sampling period (as defined in 5.1) in order to identify, characterize, and map current foraging areas, roost trees, and home ranges, as well as determine bat use of, and movement between these areas. All Indiana bats captured during the mist netting surveys, with a target of 4 Indiana bats per sampling period, shall be fitted with a radio transmitter. Telemetry studies shall prioritize tracking of female Indiana bats, although tracking of males and juveniles may also be conducted. The bats shall be tracked as long as the signal can be detected. Roost trees shall be identified and mapped during daylight hours and used as starting points for the next night's tracking. Triangulation methods shall be used to establish bat locations during night tracking. Because monitoring must be geared to evaluating the response of the bats at the colony level, mist netting and telemetry work shall be designed to include tracking as many different bats as possible, and tracking shall be conducting during the three sampling periods within the maternity season: pregnancy (May 15 – June 15); lactation (June 15- July 15); post-lactation/juvenile volancy (July 15 – August 15).

5.7 Upon identification of a roost tree from telemetry studies, the applicant shall gather information to document the location of the roost and record site-specific data relative to the roost area. For each tree containing a roost used by an Indiana bat, the species, the height, diameter at breast height (dbh), condition (alive or dead), aspect, elevation, and the percentage of exfoliating bark shall be recorded. Distances from the roost tree to other roosts used by the bat(s), to the nearest perennial and intermittent stream, and to the edge of mining, tree clearing or other related disturbances shall be measured. Percent canopy closure above roost trees and habitat cover type near each roost shall also be recorded. Roost trees shall be marked in a manner sufficient to identify the trees in the field.

5.8 The applicant shall conduct emergence counts in order to determine the size of the maternity colony, and document the colony's rate of production. Emergence counts shall be conducted at all roost trees actively used during the previous year and any new roost trees identified during that monitoring year. Emergence (dusk) counts shall be conducted at each identified roost tree at least once weekly throughout the period from April 1 and continue through August 15 or until the bats' departure in the fall (defined as at least one week beyond the date that no bats are found emerging from any known roost tree), whichever is later. When two or more roost trees are under observation, emergence counts shall be conducted at least bi-weekly (every second week) at all known roost trees simultaneously to determine overall size of colony. Specific trees may be dropped from emergence counts if no bats are documented using that tree for five consecutive emergence counts, and if no bats have been documented using that tree during that time period through other sampling methods (telemetry/acoustical monitoring).

5.9 In order to document the fate of affected Indiana bats during hibernation, the applicant shall coordinate with the Service to design and conduct a study to determine the source hibernacula of Indiana bats that will be impacted by the project. Efforts should include stable isotope analysis and providing banding information to individuals conducting hibernacula surveys. Other tracking methods may also be used to accomplish this objective. Study plans shall be submitted to the Service within one year of the date that this biological opinion is issued, and at least 45 days prior to the initiation of the study. Studies shall begin no later than the second hibernation period after the project is initiated. Study plans may be modified or discontinued with concurrence of the Service based on the results of previous years' surveys.

5.10 The applicant shall monitor bat boxes constructed and installed as outlined in the Biological Assessment (Apogee 2004a). The bat boxes shall be monitored and maintained for the life of the project, and findings shall be reported in accordance with 5.11 below. Monitoring shall be conducted by annually inspecting each box at least twice per sampling period for signs of bat usage (fecal matter, bats present, etc.). If a box shows signs of Indiana bat usage, that box shall be monitored consistent with the protocols for roost tree monitoring as defined in 5.8.

5.11 The applicant shall notify the Service and the WVDNR within 5 days of the capture of each Indiana bat. Field data relative to captures and observations of the Indiana bat shall be reported regularly to the Service in an informal manner as notable events occur. An annual report of all findings regarding the Indiana bat including raw data shall be furnished to the Service with copies to the Corps of Engineers, and the WVDNR no later than January 15 following each monitoring year. This report shall include all data gathered during the study season, methods, data analysis, and a description of the mining, reclamation, and monitoring planned for the next year. In order to ensure compliance with the established level of incidental take, the applicant shall also document the amount of roosting and foraging habitat (in terms of the forested acres and feet of stream impacted) that was disturbed the previous year, and any stream or forestland reclamation efforts that were implemented that year. Contact information for the Service and the WVDNR, as well as reporting requirements for the discovery of dead or moribund bats is found under 8.3.

5.12 Study plans may be modified with written concurrence of the Service based on the results of the previous years' efforts.

RPM 6: Monitor water quality and biotic health of streams within the action area to quantify the amount and type of take of Indiana bats.

Indiana bats are known to concentrate foraging behavior around streams and riparian areas (Hobson, 1993; USFWS, 2001; Romme, 1995). Streams provide an important source of prey for Indiana bats (Kurta & Whitaker, in press). Aquatic benthic organisms are suceptible to changes in water quality. The draft programmatic environmental impact statement on mountaintop mining/valley fills in Appalachia (USEPA 2003) macroinvertebrate study showed that the EPT index (an index of combined orders Ephemeroptera, Plecoptera, and Trichoptera) was significantly lower in stream portions below some valley fills than in reference streams. The draft EIS also showed increased concentrations of numerous chemical parameters downstream of some valley fills. If biological and chemical degradation results from the proposed project, this could reduce the amount of Indiana bat prey that are produced by remaining streams in the action area, causing bats to spend increased energy foraging greater distances from their roosts; or cause adverse impacts to foraging Indiana bats from exceeding toxic thresholds through food chain bioaccumulation of aquatic insects. Water quality and biotic monitoring will assist in determining the cause and effect of any observed adverse effects to Indiana bat prey base, and allow appropriate, focused, remedial measures to be developed and implemented.

<u>RPM 6: Terms and Conditions</u>:

6.1 The applicant shall monitor water quality within the mainstem of Sandlick Creek and its tributaries over the life of the project, beginning the first season after permit issuance. Such monitoring shall be conducted twice annually, with results reported to the Service annually concurrently with the reporting requirement under 5.11. Monitoring shall occur once annually during each of the following time periods: February 15 – April 15, and October 15 – December 15. Monitoring shall include the following: full metal suite, pH, dissolved solids, total suspended solids, specific conductance, alkalinity, potassium, acidity, and nitrate/nitrite. Water quality samples shall be collected and analyzed using procedures outlined in the most recent version of Standard Methods for the Examination of Water and Wastewater (Greenburg et al. 1992). Detection limits shall be at or below the chronic aquatic life water quality criterion for each parameter.

6.2 The applicant shall conduct bio-monitoring of the mainstem of Sandlick Creek and its tributaries, at the same stations used for water quality monitoring (as specified in 6.1, above), over the life of the project, beginning the first season after permit issuance. Bio-monitoring shall be conducted in accordance with Rapid Bioassessment Protocols and/or the methods used in Green and Childers (2000). Monitoring shall occur once during February 15 – April 15, and once during October 15 – December 15, concurrently the water quality monitoring. Results of this effort shall be reported simultaneously with water quality monitoring results. A detailed protocol shall be submitted to the Service for review and concurrence prior to initiation of the sampling.

6.3 Any water quality degradation below state and federal water quality standards and remedial actions taken shall be described in the annual report.

6.4 The applicant shall submit a water quality monitoring and bio-monitoring report to the Service and the Corps annually by January 15 of each year. In addition to the results of the previous years' monitoring, the report shall include a discussion as to the condition of the streams as compared to the baseline condition described in this biological opinion and the applications for the Clean Water Act section 404/surface mine permits. Also, the report shall include a summary that compares these results to any information regarding Indiana bat habitat usage throughout the area (as determined by RPM 5 above).

6.5 The applicant shall conduct water quality and bio-monitoring sampling as described in 6.1 and 6.2 at ten sampling stations in the following locations as described in the Potesta and Associates (2000) section of the August 2003 Laxare East Surface Mine application for Corps of Engineers permit.

- ER 20: mouth of Long Branch of Sandlick Creek
- ER 21: Sandlick Creek downstream of Orchard Branch
- ER-24 (Orchard Fork off Sandlick)
- ER 26: Sandlick Creek upstream of unnamed Tributary 1200
- ER 28A: left descending fork of Sandlick Creek
- ER 29A: Sandlick Creek – 0.3 miles upstream of ER 28C
- ER 52: mouth of Sandlick Creek
- ER 31: mouth of right descending branch of Sandlick Creek
- ER-58 (new point in Sandlick below Long Branch. Not in the Potesta report. Completes coverage of Sandlick)
- One additional station to be selected based on the results of surveys conducted under RPM 2.

6.6 The bio-monitoring plan may be modified with written concurrence of the Service based on the results of the Indiana bat habitat use monitoring.

RPM 7: In order to ensure that no hibernacula will be impacted by the project, the permit area and adjacent areas shall be surveyed to determine whether any winter habitat is present.

Indiana bats use caves or old mine portals for winter hibernacula. In order to ensure that take does not exceed the Incidental Take Statement due to removal of any winter hibernacula, a survey for old mine portals or caves in the Laxare East and Black Castle permit areas is necessary. Deep mines constructed before the 1977 Surface Mine Control and Reclamation Act (SMCRA) were often not mapped so reliance on old mine maps for potential deep mines is not sufficient. Because blasting could damage old portals that occur an unknown distance from the blast site, it is necessary to include in the survey adjacent areas within 1000 feet of the permit boundaries. The area that was proposed to be logged in preparation for mining in 2004 was surveyed in the early spring of 2004 and the information from that survey was considered in our biological opinion. This area does not need to be resurveyed.

<u>RPM 7: Terms and Conditions</u>:

7.1 Prior to project initiation, the applicant shall survey the permit area and adjacent areas within 1000 feet of the permit boundaries for potential Indiana bat hibernacula either on foot or by vehicle, during late fall to early spring when portals or caves would be the most visible. Any open portals or caves shall be evaluated by a qualified bat surveyor (as defined in 5.2) using the Phase I portal survey form. The completed forms shall be provided to the Service for review within 30 days. The Service will determine at that time whether additional surveys, such as mist net or harp trap surveys, of the openings are warranted. If they meet criteria, a bat survey of the portals shall be conducted according to protocols to be provided by the Service in order to determine bat use of the portals. Any portals that are located shall not be disturbed or modified until it is determined that they are not being used by listed bats. If listed bats are discovered to be using the permit area or adjacent areas as winter habitat, consultation must be reinitiated.

RPM 8: Implementation of these minimization measures shall be ensured by training all project personnel as appropriate, allowing the Service to inspect the project, and promptly reporting any Indiana bat finds.

The Corps and the applicant have the responsibility to ensure that all RPMs and their associated terms and conditions are fully implemented over the life of the project, and that the permitted level of take is not exceeded. Unless workers on-site are familiar with the terms of the BO and the presence of the bat, they may inadvertently engage in actions that would adversely impact the bat in violation of the terms and conditions of the BO. The opportunity for periodic inspections will further ensure the terms and conditions are enforced. Established procedures for reporting any dead or injured bats will assist in accurately monitoring the level of take.

RPM 8: Terms and Conditions:

8.1 In order to ensure compliance with these terms and conditions, the applicant shall instruct all personnel operating within the permit area and their supervisors as appropriate about the requirements and restrictions identified within, or developed as required by, the terms and conditions of this BO before construction begins. These requirements and restrictions shall be placed as special provisions in contract specifications and described in any work manuals as appropriate.

8.2 Employees of the Service and the WVDNR shall be granted right of access to the project at any reasonable time and with reasonable notice for the inspection and monitoring of the terms and conditions of this BO.

8.3 In the event that direct mortality of bats is detected or that dead, injured, or moribund bats are found, the following procedures shall be followed:

a. Throughout the duration of the project, the licensee, their designee, or the approved bat surveyor shall notify the Service and the WVDNR regarding the discovery, and the circumstances surrounding the discovery, of any dead, sick, or injured Indiana bat or other bat where the species determination is unclear. The Service Law Enforcement Officer (Special agent, Charleston, WV 304-965-6059), Project Leader (West Virginia Field Office, Elkins, WV 304-636-6586; fax 304-636-7824), and the WVDNR (Scientific Collecting Permit Coordinator or the Endangered Species Coordinator, Wildlife Diversity Program, Elkins, WV, 304-637-0245; fax 304-637-0250) shall be notified within 4 hours of discovery of an injured Indiana bat, and within 24 hours of a dead Indiana bat.

b. In conjunction with the proper preservation of any dead specimen(s), the licensee, their designee, or the approved bat surveyor shall attempt to insure that evidence intrinsic to determining the cause of death of the specimen is preserved to the maximum extent practicable. Within five calendar days of the discovery of any dead, sick, or injured bat, the licensee, their designee, or the approved bat surveyor shall provide any known information to the Service describing the circumstances, location, et cetera, of any such discovery, and the measures specific to the incident, if any, that were taken to avoid injury or death.

The reasonable and prudent measures, and their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If during the course of the action, the numerical or narrative levels of incidental take are exceeded (see Table 16), such incidental take represents new information requiring reinitiation of consultation and a review of the reasonable and prudent measures provided.

CONSERVATION MEASURES

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Bat Boxes and Watering Holes
One of the applicant's proposed conservation measures was proposed installing bat boxes and water holes as part of their mine reclamation plan. In previous cases, Indiana bats did not begin to use these structures for a number of years after installation. In cases where Indiana bats have used these structures, the boxes were installed in forested habitat near natural water sources where natural known roost trees were present. Kentucky Indiana bat Guidelines (KDSMRE et al, 2000) recommend that bat houses be used only in addition to other methods of preserving or creating roost trees. Therefore, installation of bat boxes may provide limited supplemental habitat for roosting when placed within or near other existing trees suitable for roosting/maternity activity, and may be used to augment habitat when lack of roosting trees is a limiting feature, such as around the western roost area.

Indiana bats have been seen drinking, and to a lesser extent foraging around impounded water sources such as the watering holes proposed by the applicant (Gardner et al, 1991(a)). Created watering holes will not have the same biological inputs or ecology as natural stream courses and are not expected to provide a similar a prey base. However, they may provide additional drinking water for within the permit area. The Kentucky Guidelines (KDSMRE et al, 2000) recommend that one of these features be placed every for every 50 acres of permit area (the applicant proposed one every 250 acres), and that all watering areas be placed immediately adjacent to existing trees. We therefore recommend that the applicant construct a watering area and a group of five bat boxes for every 50 acres lost during the proposed mining in the action area.

Reforestation
As a minimization measure, the applicant has proposed to put into place a post-mine re-vegetation plan that will prevent erosion, provide future travel corridors and foraging areas for Indiana bats, and includes trees known to be used by Indiana bats. Forest land is the proposed post-mining land-use. However, site and soil preparation, seeding mixtures, and tree species proposed by the applicant to achieve the forestry post mining land use will not result in the successful re-establishment of forested habitat needed to support Indiana bats within the life of the project. Implementation of an enhanced reforestation plan, as described below, may increase the potential that forested habitat may become established within the action area at some point in the future. We recommend that:

1. The applicant follow the reforestation guidelines specified by the Powell River Project (Burger and Zipper, 2002), except that a minimum of 450 trees/acre will be planted, and a minimum of 50 percent of all seedlings be selected from the following species known to be utilized by the Indiana bat as roost trees. As much as possible after considering species-specific requirements relative to aspect, soil moisture, spoil quality, etc., species will be randomly mixed to avoid large monocultural areas.

    Shagbark hickory (*Carya ovata*)
    Shellbark hickory (*Carya laciniosa*)
    Bitternut hickory (*Carya cordiformis*)
    Silver maple (*Acer saccharinum*)
    Green ash (*Fraxinus pennsylvanica*)
    White ash (*Fraxinus americana*)
    Eastern cottonwood (*Populus deltoides*)
    Northern red oak (*Quercus rubra*)
    Post oak (*Quercus stallata*)
    Red oak (*Quercus rubra*)
    White oak (*Quercus alba*)
    Slippery elm (*Ulmus rubra*)
    American elm (*Ulmus americana*)

2. All plantings be monitored for five years and corrective measures will be taken if the plantings do not meet 80 percent tree survival and species composition goals.

3. A registered professional forester develop a site and soil preparation plan, a fertilization and herbaceous seeding plan, a tree planting plan, and a monitoring plan, following the Burger and Zipper 2002 reclamation guidelines referenced above.

REINITIATION OF FORMAL CONSULTATION

This concludes formal consultation on the action outlined in the Corps' request. As required by 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such a take must cease pending reinitiation.

Conditions that may the trigger the reinitiation clause described above may include but are not limited to:

1. Indiana bats are found to be using portals within a 5-mile radius of the project area.

2. Monitoring reveals a maternity colony of a size larger than the level of take outlined in the ITS.

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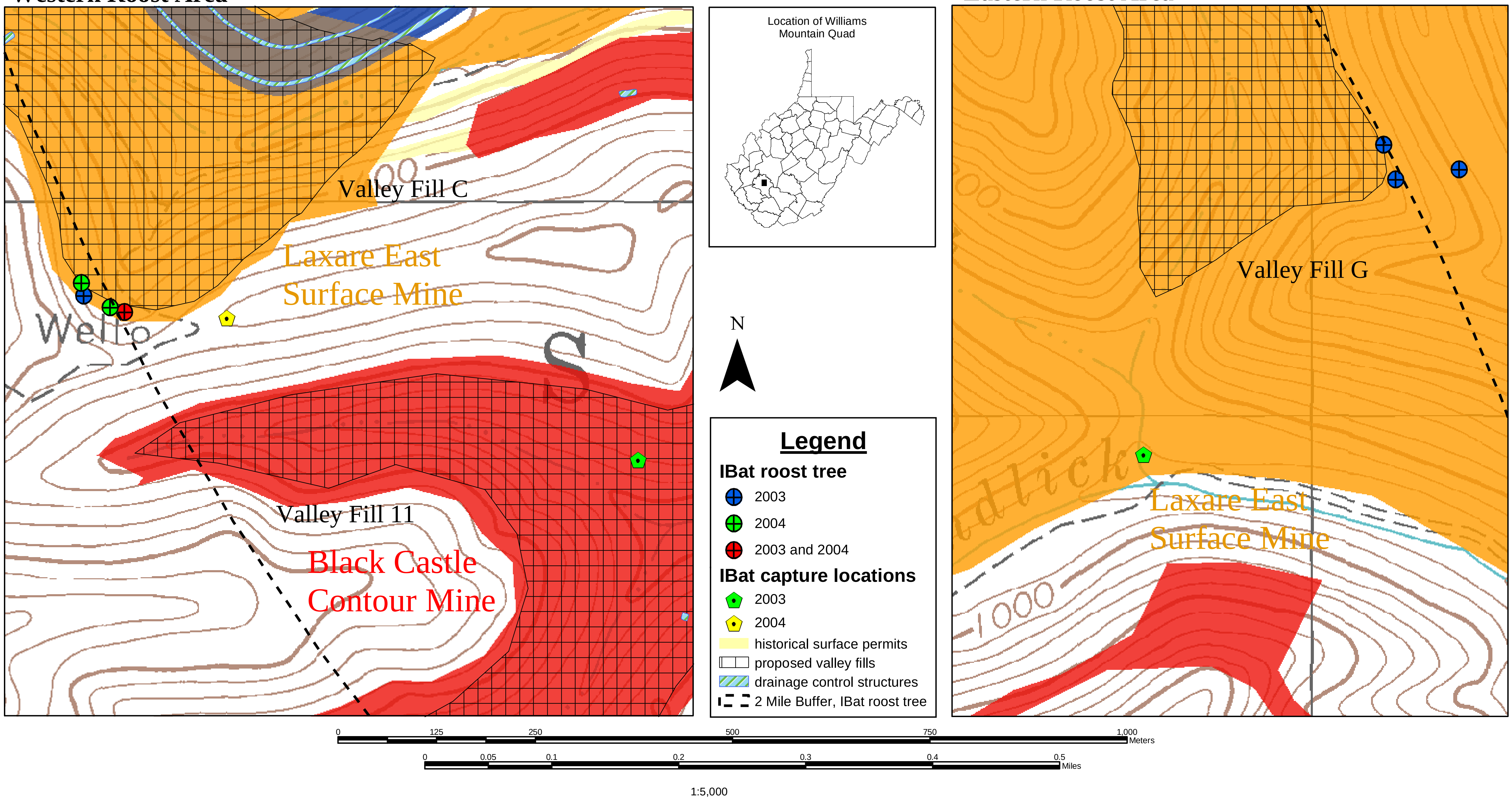
Figure 5. Close up view of 2003 and 2004 Indiana Bat capure sites and roost tree locations in the project area.

Western Roost Area

Eastern Roost Area



Indiana Bat capture and roost locations provided
by Apogee Environmental Consultants, LLC.
Spatial data acquired from West Virginia DEP.
Black Castle Contour valley fills were digitized
heads-up from permit proposals.
Map Projection: NAD_1983_UTM_Zone_17N
Graticule Units: degrees, minutes, seconds
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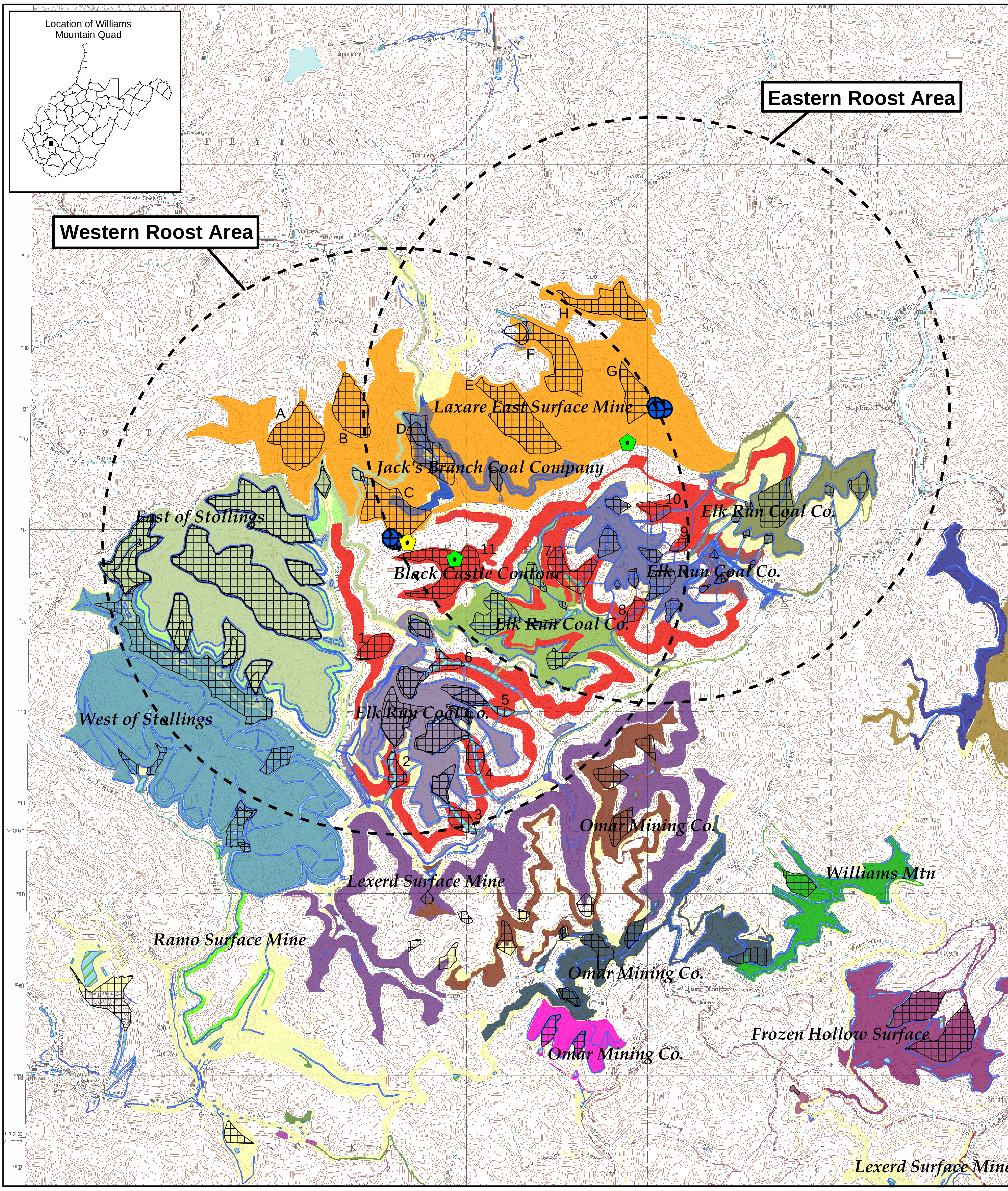
6 January 2004

U.S. FISH & WILDLIFE SERVICE Figure 4

Figure 4. Extent of all existing surface mining permits in the vicinity of the proposed Laxare East and Black Castle Contour projects.



Legend

IBat capture locations

- 2003
- 2004
- Indiana Bat roost tree
- 2 Mile Buffer, IBat roost tree
- valley fill
- drainage control structures
- historical surface permits

0 400 800 1,600 2,400 3,200 4,000 Meters

0 0.2 0.4 0.8 1.2 1.6 2 Miles

N

1:45,000

Laxare East Surface Mine

Black Castle Contour Mine

DEP Surface Mining Permits

Permit ID	Mine Name	Permit ID	Mine Name
s004900		s502401	Lexerd Surface Mine, Independence Coal Co.
s005300		s502496	Lexerd Surface Mine, Independence Coal Co.
s007076	Omar Mining Co.	s502898	West of Stollings, Elk Run Coal Co.
s007984	Jack's Branch Coal Company	s502995	Williams Mtn, Pine Ridge Coal Co.
s017373		s503095	Frozen Hollow Surface, Asset Mining
s067500		s503190	Omar Mining Co.
s500696		s505792	East of Stollings, Elk Run Coal Co.
s501000		s507586	Elk Run Coal Co.
s501200	Laxare East Surface Mine, Independence Coal Co.	s600687	Elk Run Coal Co.
s501400	Ramo Surface Mine, Independence Coal Co.	s601189	Elk Run Coal Co.
s502300	Black Castle Contour, Elk Run Coal Co.	s601487	Elk Run Coal Co.
s502387	Omar Mining Co.	s602688	Elk Run Coal Co.

Spatial data acquired from West Virginia DEP.
Surface Mine Permits are currently permitted sites.
Permits s-5023-00 and s-5024-01were digitized heads-up from permit proposals.
Historical Surface Permits are from older records and include pre-law mined sites and released sites.
Map Projection: NAD_1983_UTM_Zone_17N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
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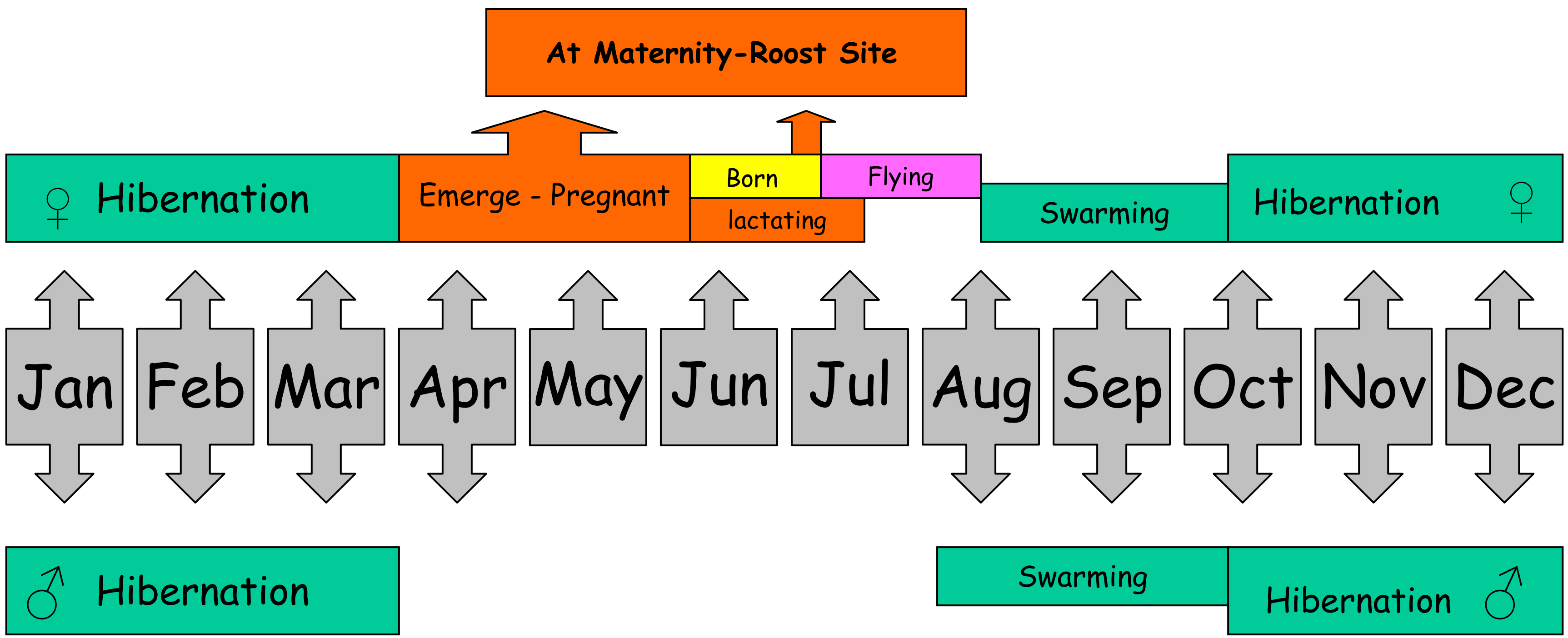
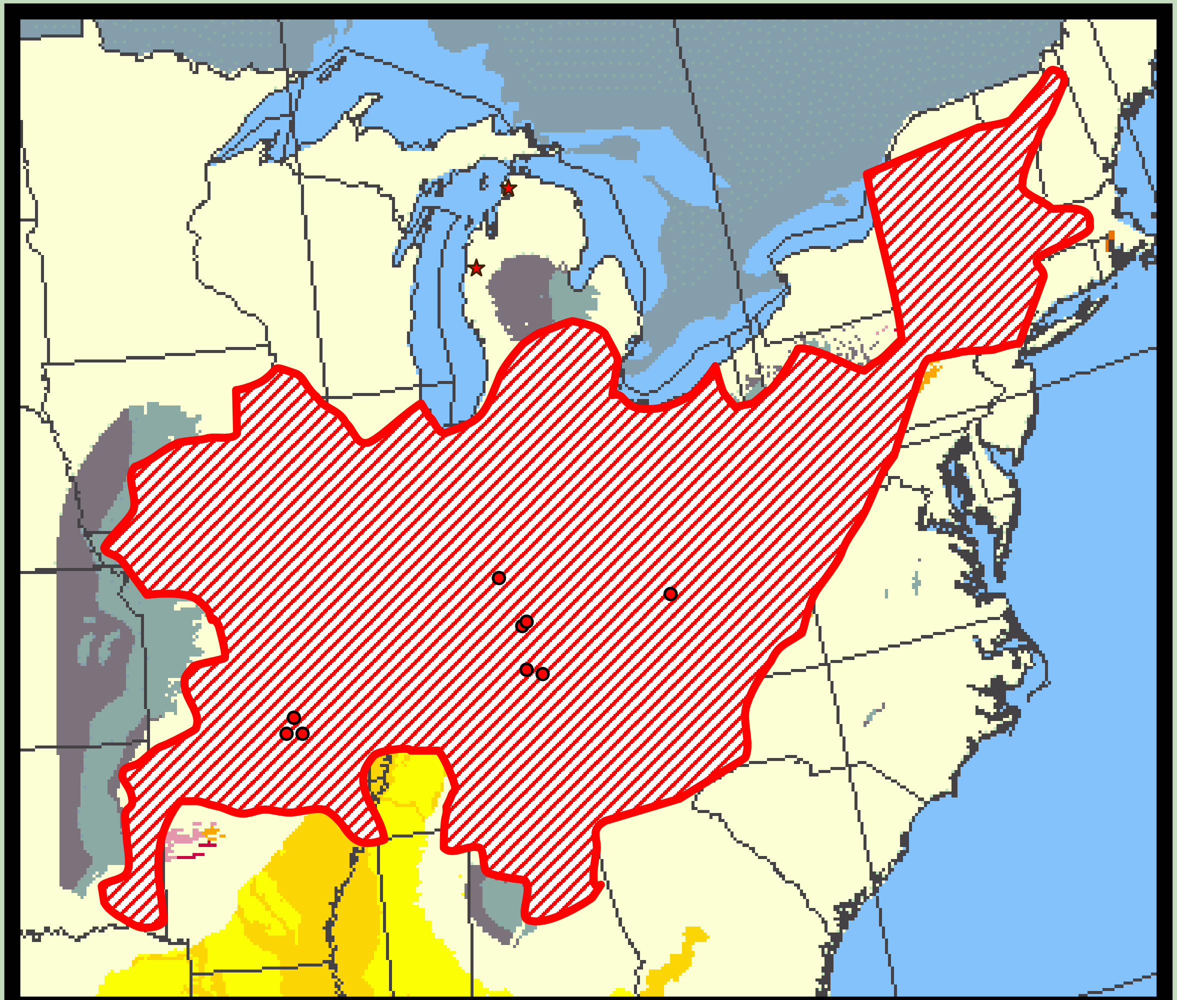
Figure 3. Indiana Bat Annual Chronology



U.S. Fish & Wildlife Service

Figure 2

Range of the Indiana Bat (*Myotis sodalis*) in relation to Eastern U.S. Coal Fields



- Approximate Indiana Bat Composite Range (summer and winter)
- Isolated Record
- Priority I Hibernacula (>30,000 bats since 1960)
- Anthracite (potentially minable)
- Lignite (potentially minable)
- Low Volatile Bituminous (potentially minable)
- Medium and High Volatile Bituminous (potentially minable)
- Medium and High Volatile Bituminous (other uses)

Bat Conservation International

Coal field and Indiana bat range (based on data compiled by Bat Conservation International) boundaries were accessed via The National Atlas of the United States (http://nationalatlas.gov). Map prepared by Andrew King, Bloomington, Indiana Field Office, U.S. Fish and Wildlife Service.

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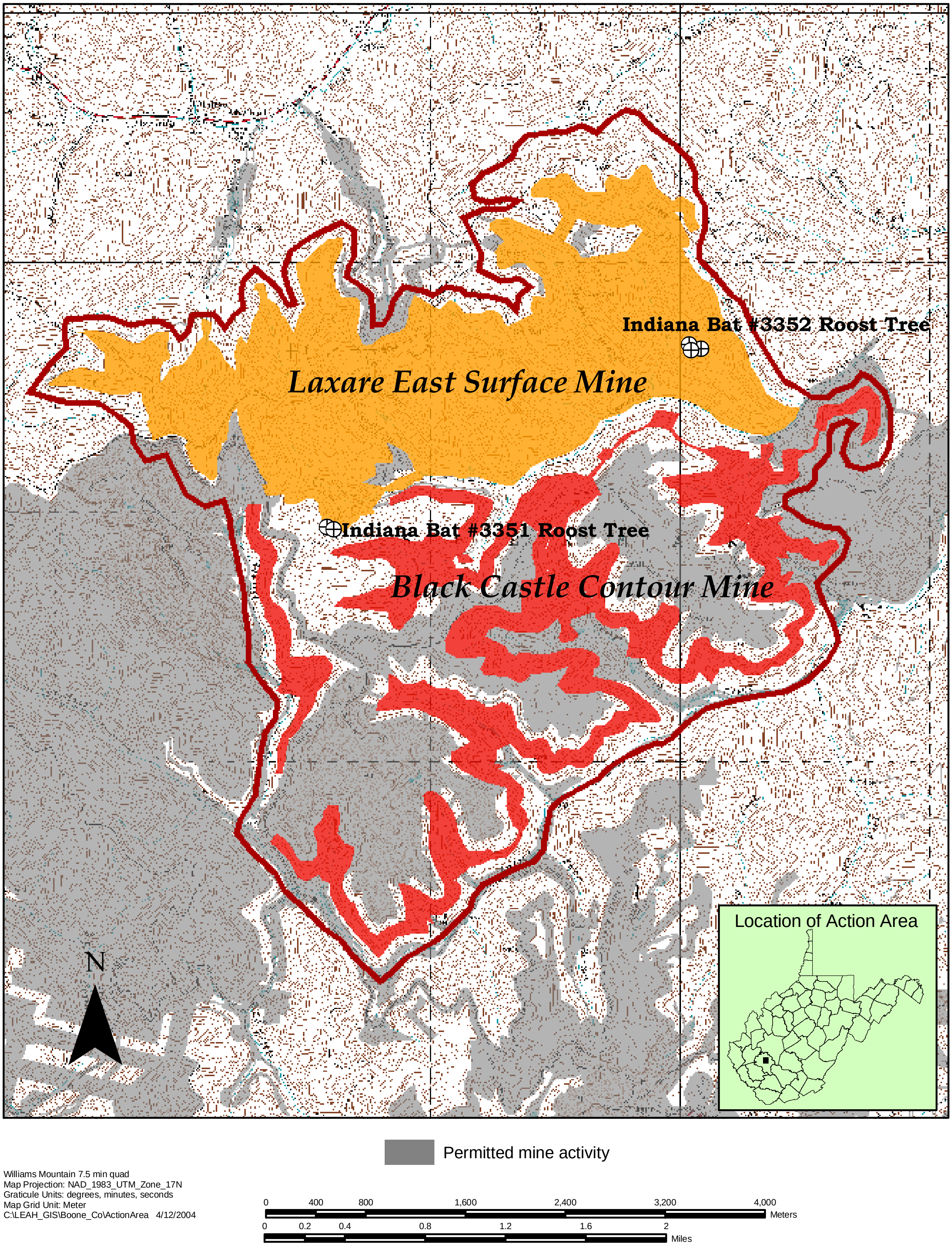
Figure 1

Figure 1. Action area includes proposed Laxare East Surface Mine and Black Castle Contour Mine



Williams Mountain 7.5 min quad
Map Projection: NAD_1983_UTM_Zone_17N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
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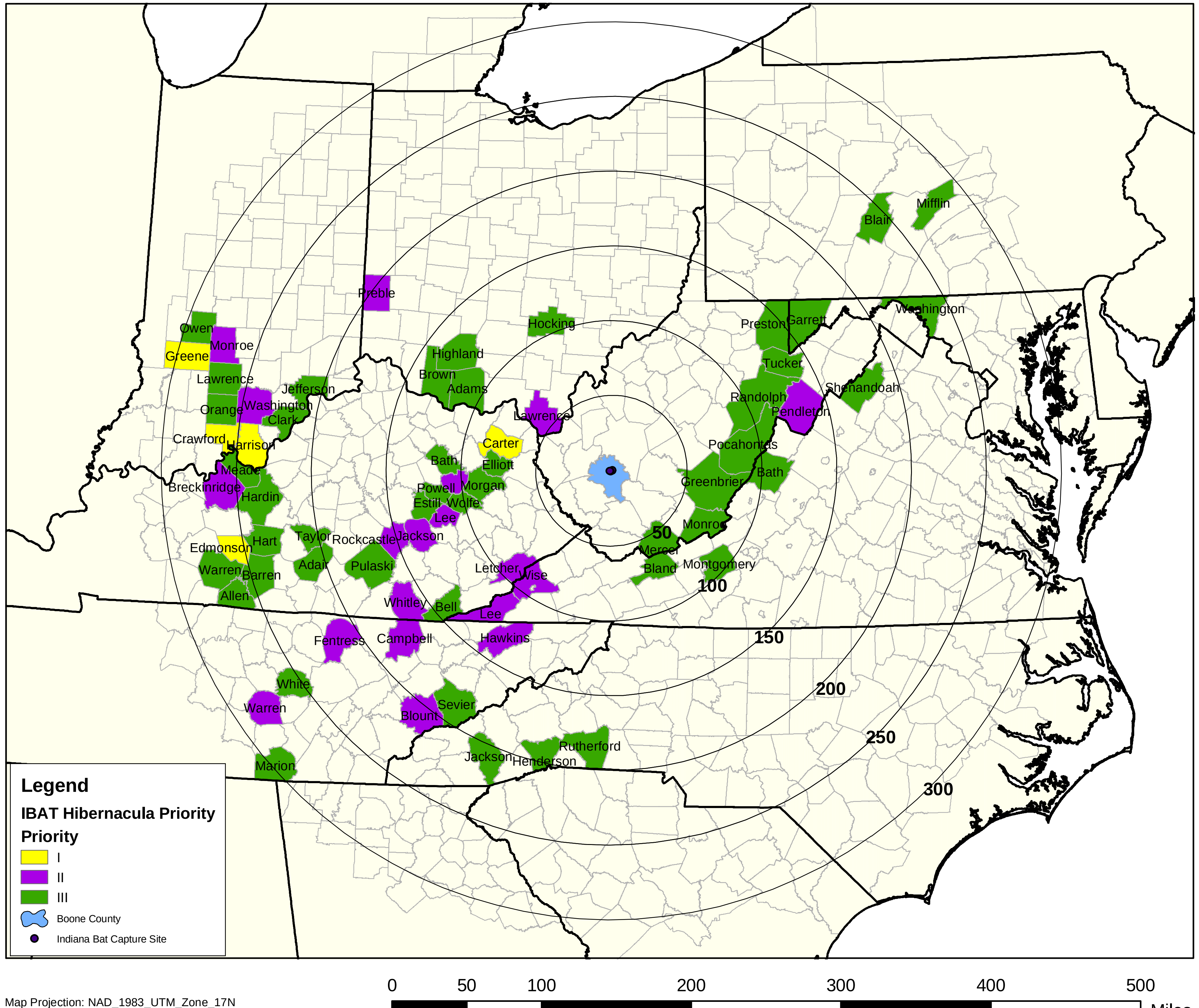
Figure 6. Indiana bat Priority I, II, and III hibernacula within 300 miles of Boone County, West Virginia, capture sites.



Map Projection: NAD_1983_UTM_Zone_17N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
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